THE POLAR RECORD

OL. 10, NO. 68, MAY 1961

A Journal of Arctic and
Antarctic Exploration and Research

s. 6d.
Issued by the Scott Polar Research Institute, Cambridge

THE POLAR RECORD

Editor: L. M. Forbes. Editorial Committee: B. B. Roberts, G. de Q. Robin,
Sir J. M. Wordie

Vol. 10 May 1961 No. 68

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THE INFLUENCE OF MAN ON THE FLORAS AND FAUNAS OF SOUTHERN ISLANDS

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[*MS. received 7 February 1961.*]

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Introduction

Most of the world's tropical and sub-tropical oceanic islands were settled by man, and their floras and faunas modified by his activities, some centuries before the development of any scientific interest in them. The original vegetation and fauna of islands like Ascension, the Azores, Bermuda, St Helena or Mauritius cannot now be described with any degree of certainty, while the native communities of many others have been markedly changed. Consequently the few remaining undisturbed oceanic islands are of great scientific importance, and many of these lie in the southern temperate and sub-Antarctic zones.

While the southern temperate and sub-Antarctic islands have not altogether escaped human interference, their chief inhabitants have, until recently, been explorers, sealers, and whalers whose visits were of short duration. During the eighteenth and nineteenth centuries most of them also harboured parties of shipwrecked sailors, for periods varying from a few days to several years. Absence of written records makes it impossible to chronicle these visits in detail, but all these groups had a significant influence on insular floras and faunas. Sealers largely destroyed the once immense populations of southern Fur Seals, greatly reduced the numbers of Elephant Seals and took a toll of penguins; there must have been consequent changes in the biological equilibrium of extensive coastal regions. Whalers and sealers together were responsible for liberating domestic stock, especially pigs, goats, and rabbits on many islands. Expeditions and shipwrecks also added involuntarily to the influx of alien species; the importation of rats to several islands can be traced to the running aground of ships.

Only the Chatham Islands, the Falkland Islands,[1] and Tristan da Cunha[2] have been settled successfully by farming communities. Abortive attempts at colonization were made on the islands of Auckland,[3, 4] Campbell,[3] and Amsterdam,[5, 6] while some livestock has been kept on Îles Kerguelen,[5, 7, 8]

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and Marion,[9, 10] Gough[11] and Inaccessible Islands.[12] Since 1945 their value as sites for weather stations has led to the establishment of semi-permanent bases on Amsterdam,[5, 6, 13] Campbell,[3] Gough,[11] Kerguelen,[5, 6] Macquarie,[14] and Marion Islands.[9, 10] Heard Island was occupied from 1947 until 1954[15] and Auckland between 1941 and 1945,[3] while stations on Bouvetøya[16] and Îles Crozet[5] are projected. There is a danger that this occupation will accelerate the disappearance of those features which render the islands especially interesting to biologists. The object of this paper is to explain why island floras and faunas are especially vulnerable, and to catalogue the changes which man has so far brought about in the southern temperate and sub-Antarctic islands.

General features of island floras and faunas

Poverty in numbers of native species

Most oceanic islands are isolated volcanoes which have arisen in mid-ocean and have never been connected to the continents by land. To colonize them, their native animals and plants have had to cross wide expanses of sea, and since most species are poorly adapted for this kind of long-range dispersal very few reach remote islands. In general, the more remote an island is from a continent, and the shorter the period for which it has existed, the more impoverished its flora and fauna will be. Many sub-Antarctic islands are not only extremely remote, but were subjected to glacial or peri-glacial conditions in the Quaternary and have therefore offered suitable conditions for life for a much shorter period than their geological age. Consequently their floras and faunas are strikingly impoverished as compared with mainland areas. Table 1 illustrates this by showing the numbers of flowering plants and beetles (two of the best-collected groups) recorded from some of the better known sub-Antarctic areas.

The absence of important animal and plant groups

Because of the difficulties of long-range dispersal across the oceans, many important groups of animals and plants do not reach the remotest islands at all. Land vertebrates (apart from birds), the dominant element in the fauna of the world as a whole, are absent as natives from all sub-Antarctic islands.[29] So are gymnosperms (including the Podocarpaceae) and the Fagaceae (including *Nothofagus* spp., the southern beeches) which provide the most characteristic dominant trees of the southern temperate continental forests. Many important invertebrate groups are similarly lacking; Gough Island, for example, has no known native slugs, millipedes, centipedes, grasshoppers, ants bees, wasps, carabid beetles, mayflies, stoneflies, dragonflies or caddis flies while other important groups are represented by a single species only.[29] Even the marine fauna shows analogous features: barnacle and mussel bands which are characteristic of temperate continental sea shores are probably absent from all the sub-Antarctic islands except Îles Kerguelen and the New Zealand shelf islands.[30]

Conversely, the absence of predatory ground vertebrates has permitted the development of the enormous populations of ground-nesting seabirds which are such a prominent feature of southern islands. It has probably also allowed the evolution of flightless land birds such as the rails of Inaccessible and Gough Islands and formerly also of Tristan da Cunha,[12] and the famous Dodo of Mauritius and the Solitaire of Rodriguez Island. The absence of herbivorous mammals has similarly permitted the development of types of vegetation highly sensitive to grazing, such as the coastal tussock grass formation which is so characteristic of the southern islands.[24]

Table 1. *The numbers of vascular plants and beetles recorded from certain sub-Antarctic and southern temperate regions*

Island	Number of native species: Vascular plants	Number of native species: Coleoptera
(*a*) Continental areas		
Tierra del Fuego	440[17]	100[18]
New Zealand, S. Island	1430[19]	
(*b*) Continental shelf islands		
Falklands	160[20]	49[21]
Auckland	150[17]	64[22]
Campbell	116[23]	26[22]
South Georgia	20[24]	7[21]
(*c*) Oceanic islands		
Amsterdam and St Paul	33[24]	4[21]
Gough	59[24]	7[25]
Heard	8[17]	6[21]
Kerguelen	28[26]	20[21]
Macquarie	35[17]	3[21]
Marion	14[27]	4[21]
Tristan group	69[24]	21[28]

Modified ecological behaviour of species

Because there are so few species on remote islands, and so many important groups are lacking, some ecological niches remain untenanted, or are filled by species which would be excluded from them in the greater competition of a continental area. Up to 40 per cent of the freshwater fauna of oceanic islands have colonized this habitat directly from the sea; on Gough Island two out of six aquatic animals have this history and have invaded the new environment almost certainly because of the absence of better-adapted competitors.[31] Lack of competition also allows species to broaden their ecological range in an accustomed habitat, developing what is termed a 'high ecological amplitude'. Many plants on Tristan da Cunha and Gough Island appear to range much more widely there than they do on the continents, occurring at almost all altitudes and in all vegetation types.[32]

Evolution of endemic species

Because of their isolation, insular species are cut off from interbreeding with continental parent stocks, and since they are subjected to different conditions, are likely to diverge from them. Peculiar 'endemic' species thus arise as adaptations to island conditions. In archipelagos an early colonizing species which spreads over several islands in which conditions are slightly different may similarly diverge in time into separate species on each island. This has happened with birds of the genera *Nesopiza* and *Nesocichla*,[12] and also with weevils[33] in the Tristan da Cunha group, although to a less spectacular degree than in the celebrated finches of the Galapagos Islands or the sickle-bills of Hawaii.[34]

In addition, the isolation of the islands and the low level of competition there may have a protective effect, allowing species to survive when their continental relatives have been eliminated by competition or environmental change. This produces a second type of endemic species, in this case a relict which originally evolved elsewhere and may be of considerable age. Several plant genera of the southern Indian Ocean islands (*Pringlea*, *Lyallia*) and of the New Zealand shelf islands (*Pleurophyllum*) probably come into this category, as do certain insect groups.

Islands may thus harbour endemic species either because those species are newly arisen, or because they are relict, and some sub-Antarctic and southern cold temperate islands have mixtures of both these types. But because most of these islands have experienced Pleistocene glaciation or recent volcanicity, few relicts have survived upon them, and there has been insufficient time for the evolution of many new endemic species. For these reasons their floras and faunas are less peculiar and less diverse than those of the older tropical islands.[33]

The causes of vulnerability

It is obvious that most of the peculiar features of insular floras and faunas result from their isolation, and since man's action in introducing alien species (deliberately or accidentally) breaks that isolation down it is not surprising that major changes ensue.[35]

Effect of selection primarily for transoceanic dispersal

Because the species inhabiting remote islands have been selected primarily for their dispersal capacity, they have not necessarily been dominant or even highly successful in their original continental setting. Consequently, if man later imports mainland species to an island, these may well prove more vigorous and efficient as competitors than those which arrived by natural means. It is therefore easy for them to establish themselves and spread into the native communities where they may supplant the native species or greatly restrict their range.

It is probably a valid generalization that the more dominant a species is in a continent, the more rapid and catastrophic will be its effect when imported to an island of comparable terrain and climate. Land mammals are the dominant faunistic element over all the world's continents to-day, and it is not surprising that their impact on the communities of isolated islands is especially profound. The importation of predators like cats, rats, or dogs has in many cases caused the extermination of flightless birds which have evolved in their absence, and the radical reduction of the populations of ground nesting sea birds. The introduction of herbivores like cattle, sheep, goats or rabbits has caused the devastation and wholesale disappearance of the most vulnerable vegetation types, like tussock grassland.

Simplicity of the ecosystem

In any one habitat on an oceanic island very few species are involved in the complex interacting network termed the ecosystem. This inevitably leads to diminished stability,[35] for when one species suffers from an attack by a predator or parasite or grazing mammal there may be no others which can take over its role in the community. This is well illustrated by the fate of the tussock grasslands of Macquarie Island, whose single dominant, *Poa foliosa*, is extremely susceptible to rabbit grazing and is the only native species capable of stabilizing the soil on steep slopes. Where it is attacked the whole community of some twenty-three species breaks up and widespread erosion follows.[17, 36]

Lack of indigenous species adapted to conditions produced by man

Man disturbs natural vegetation by cutting, burning, and cultivation, and indirectly by stocking the land with grazing animals. As a result communities are rendered more open, and plants characteristic of early seral stages (therophytes) spread. On remote islands therophytes are absent or very scarce,[37] and there are often no native species capable of rapidly recolonizing the disturbed areas. Patches of bared ground which would quickly be clothed with vegetation on a continent may remain exposed long enough for erosion to begin. On the other hand, the plant species commonly introduced by man include many therophytes adapted to these conditions, and they quickly exploit the cleared areas. Many common weeds of the north temperate zone (Table 2) are now widespread as introduced species in the sub-Antarctic and southern temperate islands. The effects of human interference are therefore additive: burning or grazing not only checks the native vegetation but accelerates the spread of alien plants.

The destruction of insular floras and faunas

Atlantic islands

Tristan da Cunha

Until its occupation by settlers in 1810, the lower levels of Tristan da Cunha, including the north western coastal plain, were covered in dense thickets of the low-growing tree *Phylica arborea*, interspersed with ferns, tree-ferns, and tussock grasses. The steeper slopes probably supported dense tussock grassland. Higher up the 6,760 ft. volcanic cone there were a variety of bog, wet heath, and feldmark formations.[32] Great colonies of ground-nesting petrels and shearwaters were a feature of the island, and albatrosses and an endemic flightless rail (*Porphyriornis nesiotis*) were also abundant.[11, 12, 38]

Burning, grazing, and the cutting of wood have since eliminated the natural vegetation from the entire north-western coastal plain, and the other smaller lowland plains on the east and south of the island. Extensive burning of tussock grassland is recorded in 1824.[39] The bush and grassland have been replaced by a heavily grazed turf incorporating many introduced species.[32] Overgrazing by semi-wild cattle at free range has caused erosion on the southern areas of lowland plain, at Cave Point and Stony Beach, and the areas of unstable sand near the main landing place in the north-west may once have been covered by tussock. The small tussock grass, *Poa flabellata*, does not now occur on Tristan da Cunha, but it is possible it has been eliminated by grazing and formerly grew on the large sections of the main cliff-slopes that now support fern-sward. Higher up the Peak a whole vegetational zone is now dominated by the introduced species *Holcus lanatus* and *Rumex acetosella*, and this too may once have been dominated by native grasses.

Goats were probably landed by the Portuguese and were numerous in 1790,[2] and pigs had run wild by 1824,[39] but neither species is recorded as a major pest and both have now been exterminated. Cattle, sheep, goats and pigs were on the island in 1829.[40] At the present time cattle and sheep are the main grazing animals (both being only partly confined by fences), while there are donkeys, pigs, geese and fowls near the Settlement.[2, 11] Rabbits are said to have occurred in 1829,[40] but to have been extinct in 1873.[41]

The principal feral predatory mammals on Tristan da Cunha are rats and cats. The rats came ashore from a ship wrecked in 1882, but since two subspecies are present, may well have been reinforced by later introductions.[42] They have almost certainly been responsible for the extermination of the endemic flightless rail and the great reduction in the petrel colonies.[12] Cats were brought to the island by the early settlers and soon ran wild; today, though widely distributed, they are not numerous. Human slaughter of many bird species for food has contributed greatly to the decline of the petrel, penguin, and albatross populations and caused the extinction of the Wandering Albatross as a breeding species.[12]

Numerous alien plants are established on Tristan da Cunha. In 1937, forty-four out of seventy-four known flowering plants were believed to have been introduced, and the total is certainly larger today.[32, 43] Many of these have spread throughout the natural vegetation, and the same is true of imported invertebrate animals like slugs, millipedes, and some snails.[33]

Of the minor islands in the Tristan group, Nightingale has suffered little human interference apart from the annual harvest of some thousands of young Greater Shearwater (*Puffinus gravis*), a number of penguin eggs, and a few other birds.[12] Inaccessible Island once supported goats, which had dwindled to a small remnant by 1873, and feral pigs.[41] These were not recorded by a shipwrecked party in 1822 but were abundant in 1873.[41, 44] They are described as damaging tussock grasses and other plants, but feeding chiefly on birds and their eggs: a penguin rookery on the south coast is said nearly to have been exterminated by them. In 1938 however only one pig was present, and about seven sheep,[12] and probably no such animals survive there today. Inaccessible Island has also been damaged by fires, one of which, lit among tussock grass in 1909, is said to have burned for a month.[12] Rats and cats were absent from Inaccessible and Nightingale Islands in 1938 and probably are still, but occasional dogs have been left there by Tristan Islanders.

Gough Island

Gough Island resembles Tristan da Cunha in its vegetation and fauna, but remains in a virtually natural state. Until 1956 no grazing animals had been imported. In that year about ten sheep were landed to provide meat for the South African Weather Station,[11] and since then the number has fluctuated, but remained below thirty. The sheep have been confined to part of the Glen and above Capsize Sands, and have attacked the *Poa flabellata* tussocks selectively, reducing the abundance of this species in these areas.[45] One or possibly more, goats were landed in 1958, but their destruction was immediately ordered by the Tristan da Cunha Administration. A few domestic fowls are kept.

The only predatory animal on Gough Island (in 1960) is a single pet dog, and mice are the only other introduced mammals. Twelve alien plants are recorded out of a total vascular plant flora of seventy-one, but only a few of these have so far become established in native vegetation (Table 2).[45] The number of alien invertebrate animals is also much smaller than on Tristan da Cunha.[33]

Falkland Islands

Cattle were introduced to the Falkland Islands in 1764, and soon ran wild, as did horses and rabbits. Sheep were imported later, and farmed extensively. The onslaught of these mammals, and destructive burning by early settlers, has caused the native tussock grass, *Poa flabellata*, to disappear almost everywhere except on small off-lying islets.[1, 46]

South Georgia

South Georgia is virtually an Antarctic island, with permanent snow above 2000 ft., and a highly impoverished flora and fauna. Only twenty species of vascular plant are recorded; of these *Poa flabellata* is the largest and dominates large areas of coastal tussock grassland. Inland there is a tundra meadow of grasses, sedges, and *Acaena adscendens*.[47] There are large colonies of breeding sea birds and two endemic land birds, a pipit (*Anthus antarcticus*) and a teal (*Anas georgica*).

Rabbits were introduced to South Georgia in 1872, but failed to establish themselves then or later. A small population survived on Jason Island, off Cumberland Bay, in 1930.[47] Sheep have also been imported without success. Horses, imported in 1905, died out after a while, but reindeer, introduced in 1911 and 1912, have established themselves and number some hundreds, ranging over a small part of the island.[47] The effect of these animals is uncertain.

Rats were brought to the island by sealers in about 1800 and are numerous and widespread in the coastal grasslands, causing serious destruction of th smaller petrels. Man has greatly reduced the populations of Fur Seal (*Arcto-cephalus gazella*), Wandering Albatross, and the endemic teal.

Indian Ocean islands

Île Amsterdam

Like Tristan da Cunha and Gough Island, the lower levels of Île Amsterdan support thickets of *Phylica arborea*, while the upper parts are covered in we heath and bog. The native vegetation and fauna has yet to be described i detail.[5, 6] Wild hogs were abundant on the island in 1823 and there were few goats also.[48]

From 1843 until 1853 a fishing industry operated around this island an Île St Paul, but no shore-based installations were erected.[5, 6, 7] In 187 a farm was established in the north-east, only to be abandoned 8 month afterwards. Cattle introduced at this time have run wild and now increase to 1000–2000 head. They have eliminated the trees from much of the norther part and check regeneration by biting off young saplings.[6] On the south an west, however, dense thickets remain in the least accessible places.[5] Much o the open country between the woodlands seems (judging by photographs)[4 to have been converted into a close-cropped grassland which has been terrace by trampling on the steeper slopes. The number of cattle is probably no regulated by winter starvation, and the higher mortality of cows and calve is said to be responsible for the remarkable sex ratio of four bulls per cow Goats were introduced by early visitors but seem to have diminished; i 1957 only one old male was reported. A small flock of sheep also existed i 1957. No soil erosion has been described, but a large scar on the side of secondary crater cone, conspicuous in photographs,[49] may owe its origi partly to the activities of man and his stock.

Predatory mammals include cats and rats, and the former are stated t have caused damage to the bird populations.[6] An attempted reduction of th cat population is alleged to have caused a compensating rise in the numbe of rats and mice, and so to have been abandoned.[5]

Many plants were introduced by the early colonists, and some at least hav invaded native vegetation, but the number and status of these is uncertain

Île St Paul

Unlike Amsterdam, the smaller and lower island of St Paul lacks wood vegetation and is largely covered by tussock grassland dominated by *Spartin arundinacea*. There is an abundant sea bird population.[5, 6]

Île St Paul was the centre of a fishing industry from 1843 until 1853 an intermittently thereafter until 1914.[7] In 1927 a crawfish fishery was base on the island, and about 120 people took up residence; after forty deaths fro beri-beri and scurvy in 1931 the venture was abandoned in 1932.[7, 8] Th fishery was revived in 1937–38, and since 1948 has been operated from ship there are no shore installations at present.[5]

Wild pigs were abundant on the island in 1823[48] and goats were liberated by fishermen in the nineteenth century, but these were exterminated to provide meat and had disappeared by 1874.[8] Sheep have only recently been imported and are not numerous.[5] Rabbits were released at some time in the last century and increased rapidly, devastating the vegetation and almost certainly causing erosion. Latterly they have decreased, probably through disease, and in 1957 it was stated that the recolonization of the bared ground by vegetation was nearly complete.[5]

Cats and rats were both numerous on Île St Paul in 1874, subsisting alike on the birds.[8] Mice also flourished. The cats have since died out but rats and mice remain numerous: the effect of the former on the bird colonies is unknown.

A number of alien plants certainly occur, but the lists and descriptions are inadequate to estimate their status. The greater part of the terrestrial invertebrate fauna is stated to consist of introduced species.[8]

Îles Kerguelen

The Kerguelen archipelago is colder and more barren than Amsterdam and St Paul, and has a very poor native flora. Tussock grassland of *Poa cookii* probably once grew on steep coastal slopes, and the famous 'Kerguelen cabbage', *Pringlea antiscorbutica*, dominated a unique vegetation type which was widespread elsewhere. The two other main vegetation types, both important in inland areas are dominated by cushions of *Azorella selago* and mats of *Acaena adscendens*.[5, 6, 7, 8, 26, 50, 51, 52, 53, 73]

The distribution of all these plant communities has been greatly modified by the effect of rabbits, liberated on the island in 1874 by an British Transit of Venus expedition, in an area where the Kerguelen cabbage was abundant and seemed likely to provide suitable food for them.[54] "Now it is the rabbit that has become abundant, and the cabbages have disappeared with many other plants whose absence has altered the appearance of the central part of the archipelago to an extent unbelievable to one who has not seen it with his own eyes."[5] The plant community dominated by *Pringlea* has become restricted to small rabbit-free islets and to cliffs,[8, 51, 53] while the tussocky *Azorella* heathland has been invaded by *Acaena*.[51, 52] The heavy grazing of all types of vegetation has broken the plant mat and allowed severe erosion by wind and water; in many places the underlying peat and soil have been stripped away and rock and moraine exposed.[55] The elimination of the native vegetation has been accompanied by the loss of the remarkable invertebrate fauna associated with it.[8, 56]

Sheep were imported in 1908 to Île Longue[7] and, in 1911, 1000 were liberated on Presque'île Bouquet de la Gryе.[7, 8] A small staff of five or six shepherds maintained the flocks, largely for the benefit of the seasonal staff of the whaling station at Port Jeanne d'Arc. This venture, interrupted between 1914 and 1921, was recommenced at Port Couvreux and Île du Corbeau, but abandoned in 1932. In 1949 a staff of about fifty men occupied a new weather station and base at Port aux Français:[5] today the personnel there number 110.[57] A wide range of livestock has been imported. In 1952 sheep were landed on Île Mussel, and later on another small rabbit-free island.[5] Proposals to establish them on other islets would certainly lead to the further reduction of the native vegetation. Mules were imported in 1949, the last being killed in 1953,[58] and Shetland ponies, pigs, and cattle are all kept around the main base.[5] Rabbit grazing is too intense to permit stock raising on any scale on the main island, but if these pests can be destroyed the present intention is to replace them with sheep. Reindeer were imported in 1955 (2 pairs) and 1956 (1 male and 5 females) and seem to be establishing themselves since the rabbits do not compete with them for the lichens which form their main food.[5]

Wild dogs have been reported from Îles Kerguelen, and reputed to descend from sledge dogs abandoned by the *Gauss* expedition of 1902,[8, 50] but this has been denied[59] and the very existence of the animals doubted.[5] Cats were present on Île du Chat in 1874.[54] Rats were introduced by whalers in the nineteenth century and occur around Port Jeanne d'Arc and perhaps elsewhere. Mice were abundant in 1875.[54] Dogs and cats from the base at Port aux Français have been stated to constitute a threat to nearby bird and seal colonies and to need control,[60] but on the whole no predator is widely dispersed and abundant over the whole island. It is rumoured that the introduction of mink is now contemplated, and this predator may cause severe damage to bird populations.

Several alien plants had become widespread in natural vegetation on Îles Kerguelen by 1903 (Table 2).[26] Recent experiments, which involve the attempted establishment of species, will certainly increase the number.[61] They will also add to the list of alien invertebrates of which several are known to be numerous around sites of human settlements.[8]

The Kerguelen archipelago is so large and complex that good examples of the natural flora and fauna almost certainly remain in the outlying and smaller islets and less frequented parts of the group. A detailed study of these is much to be desired.

Heard Island

Only small areas of Heard Island are ice-free and the vascular plant flora numbers seven or eight species only. There are large sea bird colonies. So far as is known there are no established alien mammals or plants.[15]

Îles Crozet

Like Îles Kerguelen, the Îles Crozet are covered, up to about 1200 ft., by a dense herbaceous vegetation of tussock grasses, *Azorella*, *Acaena* and *Pringlea antiscorbutica*.[5] Unlike Îles Kerguelen they remain in a relatively natural state. Pigs were established on Île aux Cochons before 1820, and by that year had become numerous and fierce.[48] They fed partly on tussock grass roots and partly on sea birds, and caused great damage in the penguin rookeries, for which reason they were exterminated in the mid- or late nineteenth century. Rabbits were said to be abundant in 1873,[41] probably in

Île de la Possession where *Pringlea* apparently grazed by them was noticed in 1938:[8] in 1959, however, none were seen on this island.[62] Goats were also reported from the group in 1875 but no details are available.[54]

Marion and Prince Edward Islands

Like the Îles Crozet, this group has a vegetation and fauna allied to that of Îles Kerguelen, [41, 63] and this has been little disturbed by man. Permanent occupation was only begun in 1947,[9] since which year the South African Weather Bureau has maintained a staff of 12 to 15 men.[10] A few sheep were imported in 1947 but failed to establish themselves, and a supply is now brought annually to the island and killed for meat when required.[10] Fowls have been kept in confinement with success. No introduced predators are reported, nor are any alien plants known to be established in the vegetation. A large number of alien bushes and trees have, however, been planted, many in soil brought from the Cape, so that the probability of inadvertent introduction of therophytes and alien invertebrates is high.

Islands south of New Zealand and Australia

Macquarie Island

Macquarie Island originally supported tussock grassland dominated by *Poa foliosa* on the steeper slopes up to 1000 ft., with herbfield (in which *Pleurophyllum hookeri* is characteristic), bog, and fen on the flatter ground and feldmark in the highest and most exposed places.[17]

Sealers were active about the island throughout the nineteenth century, and one firm introduced rabbits in 1880.[64] Until about 1930 these were not abundant, but were noted as attacking the 'Macquarie Island cabbage' *Stilbocarpa polaris*.[64] Subsequently they have invaded all except the northern quarter of the island and virtually eliminated tussock grassland from many of the steep coastal slopes.[17, 36] Widespread erosion has been caused and unless some natural check occurs (like that reported from St Paul)[5] the elimination of all this vegetation and its replacement by scree seems likely. Grazing is also affecting the upland herbfields and gullying is going on.[36]

The island was reported as suitable for sheep in 1915,[64] but was not stocked until 1947, since which year a flock of about fifteen has been kept.[17] These have caused some damage to the vegetation around "Wireless Hill", one of the few areas which still lack rabbits. Goats were also imported in 1947 but later destroyed because of their harmful effect on the vegetation.[17] Two horses were present in 1923.[65]

Dogs were wild on the island in 1821,[66] but later died out; they certainly caused some destruction of the native fauna. Cats were also introduced by sealers before 1821[66] and were abundant in 1890–94, when they probably caused the extermination of the parakeet and banded rail which took place between 1880 and 1894.[64, 65] Cats were 'not numerous' in 1930[64] but were common over the whole island in 1955.[17] Rats are numerous and widespread, and were probably also brought by sealers.[64] One alien bird, the Weka (*Gallirallus australis*) is also abundant on Macquarie Island, having been introduced in about 1879.[64, 65] Some authors state that it has little effect on native vegetation or fauna,[17, 64] but in fact it is certainly destructive of ground-nesting birds and has probably been a major cause of the decline of nine species of resident petrel.[65, 67] Man himself has almost exterminated the Fur Seal and reduced the populations of King Penguin and Wandering Albatross.[67]

Only three species of alien plant are listed from Macquarie Island, and all these are established in native vegetation (Table 2).[17] Experimental cultivations were carried out on the island in 1915, but none of the species tested seems to have become established.[64]

Campbell Island

Campbell Island lies on the New Zealand shelf and has a fairly rich flora with close neozelanic affinities. Tussock grassland covers steep slopes, especially around the coasts. Various scrub formations (dominated by *Dracophyllum* and *Coprosma* with *Suttonia*) occur low down, while peat bogs occur on both lowlands and uplands. The uplands have a wet heath dominated by *Rostkovia* and a discontinuous vegetation covers the highest rocks.[23]

Sheep farming was carried out on Campbell Island from the 1890's until 1927, the stock reaching 8000 head, and a shore-based whaling station was operated between 1908 and 1914.[3, 68, 69] About 1500 wild sheep remained in 1950,[23] and some 950 survive today. They have grazed the tussock grasslands selectively, causing the almost complete disappearance of the grasses *Danthonia flavescens* and *Poa foliosa* which were once dominant.[23] *P. litorosa* is now the main species, and is also grazed. "The sheep have probably been responsible for the exposure of patches of peat which are like ugly scars...patches which are ever enlarging as the roots of the tussock become exposed and normal erosive forces become operative."[23] However, in contrast to Macquarie, the richer flora of Campbell Island includes a species (*Chrysobactron rossii*) which is unpalatable to sheep and which is spreading locally on the grazed cliffs. The alien grass *Poa annua* is also increasing. Sheep grazing is affecting most of the larger and most interesting herbs on the island, and *Pleurophyllum hookeri*, perhaps the most interesting, is becoming confined to inaccessible rocks.

At various times goats, pigs, game birds, and guinea fowl have been released on Campbell Island, but none is established today. Rats infest part of the island, especially near the abandoned sheep-farm buildings.[3]

Forty-eight species of alien plants have been recorded from Campbell Island, making about one-third of the total flora.[23] Most are confined to coastal areas, but almost all are spreading and some, notably *Poa annua*, *Stellaria media*, *Cerastium vulgatum*, and *Sagina procumbens*, are widespread. The checking of the native vegetation by sheep is greatly assisting this invasion by aliens.

Auckland Island

Auckland lies nearer to New Zealand than Campbell, but resembles it in its general features. The main scrub vegetation is dominated by the New Zealand myrtaceous shrub *Metrosideros lucida* and the flora is richer.[68, 70]

The island was settled by about seventy Maoris in 1841,[4] and a larger colony founded by the Enderby Brothers in 1849 as a shore-based whaling settlement.[3, 4] This was abandoned in 1852[4] and the whole population had left by 1856;[3] since then there have been intermittent sheep farming attempts. Cattle were imported in 1849 but killed off later by sealers. Others were landed in 1895 on the small Rose and Enderby Islands and by 1916 the population had overgrazed its range and was suffering from starvation. A small number survive today. Sheep and goats have both been imported, but the sheep have vanished. Goats are still frequent in the north of the island. Pigs were imported in 1897[4] and have run wild causing considerable local damage to the vegetation and making serious inroads on the colonies of ground-nesting birds. Rabbits abound on Enderby and Rose Islands, but not on the mainland, and have caused severe damage to the vegetation. On Rose Island the population appeared diseased in 1942 and may have been undergoing a check similar to that reported from Île St Paul.

Wild cats are numerous and reported to be destructive of birds, but rats and other predators have not been reported.[3] There are numerous alien plants, but their detailed status is unknown.

Two southern sub-tropical islands

Although lying outside the southern temperate region, the islands of the Juan Fernandez group and St Helena present such well documented cases of the human destruction of native floras and faunas that they are worth considering here for the principles they illustrate.

Juan Fernandez[71]

The three islands of this group were discovered in 1574, and Más-á-tierra was soon afterwards settled by its discoverer, who introduced goats, pigs and donkeys. The goats thrived on the luxuriant sub-tropical native vegetation, and became such an important source of meat to the buccaneers of the seventeenth century that the Spaniards introduced mastiffs in 1686 to control them. After this the goat population declined sharply, but the dogs increased to such an extent that they became a danger to humans, and were exterminated by 1830. After this the goats multiplied again and were estimated to number 3000 in 1877. They have had a devastating effect on the native vegetation on Más-á-tierra and also on Más-afuera (where they were plentiful in 1866), and severe soil erosion has ensued, especially on the steep slopes of Más-afuera.

Several introduced species of plant were early noticed as aggressive weeds on Más-á-tierra. Oats (*Avena barbata*) and radishes (*Rhaphanus sativus*) covered large areas in 1740, and bramble (*Rubus ulmifolius*), macal (*Aristotelia *maqui*), and *Acaena argentea*, which were imported later, have also sprea widely. Their success illustrates the ease with which alien species invade disturbed native vegetation, and the history of the islands as a whole show how difficult it is to restore an equilibrium once it has been upset.

St Helena

St Helena provides a most striking case of the complete and catastrophi destruction of a whole flora by a single grazing mammal. The following accoun comes from the classic work of Wallace.[72]

> "When first discovered, in the year 1501, St Helena was densely covered with luxuriant forest vegetation, the trees overhanging the seaward precipices an covering every part of the surface with an evergreen mantle. This indigenous vegetation has been almost wholly destroyed, and although an immense number of foreig plants have been introduced and have more or less completely established themselves yet the general aspect of the island is now so barren and forbidding that som persons find it difficult to believe that it was all once green and fertile. The cause o the change is however easy to explain. The rich soil formed by the decompose volcanic rock and vegetable deposits could only be retained on the steep slopes s long as it was protected by the vegetation to which it in great part owed its origin When this was destroyed the heavy tropical rains soon washed away the soil an left a vast expanse of bare rock and sterile clay. This irreparable destruction wa caused in the first place by goats, which were introduced by the Portuguese in 151 and increased so rapidly that in 1588 they existed in thousands. These animals ar the greatest foes to trees, because they eat off the young seedlings and thus preven the natural restoration of the forest. They were however aided by the reckless wast of man.
>
> In 1709 the Governor of the island complained that the timber was rapidly disappearing, and asked that the goats be destroyed, to preserve the woods and becaus the island was suffering from droughts. The reply was "the goats are not to b destroyed, being more valuable than ebony". In 1809 the Governor reported th total destruction of the forests, and that in consequence the cost of importing fue for Government use in the one year had been £2729-7-8d. About this time larg numbers of European, American, Australian, and South African plants were imported and many of these ran wild and increased so fast as to drive out and exterminate much of the relics of the native flora!"

Summary and conclusions

Man has altered the flora and fauna of southern islands both by the direc destruction of native species and by the introduction of aliens. Direct destruction has greatly reduced populations of seals and nesting sea birds on many islands, and vegetation has been modified by cutting and burning. But by far the most radical changes have been produced by the human importatio of grazing and predatory animals. Goats have irreparably damaged St Helen and Juan Fernandez; in the colder southern islands however their influenc has been less marked and they are perhaps not perfectly adapted to the col and wet climates prevailing there. Cattle similarly have caused damage only on Tristan da Cunha and Île Amsterdam, both among the warmer island considered here. Sheep, pigs, and especially rabbits, have been most destructiv in the southern temperate and sub-Antarctic regions. The most vulnerable vegetation type in the islands is undoubtedly maritime tussock grassland, but fern-bush, wet heath, and feldmark formations have all been affected severely where grazing pressure is high. There is no doubt that in the most extreme cases the biological productivity of large tracts of land has been permanently reduced owing to the exposure of the ground to erosion and the washing of much of its soil into the sea.

The native island fauna, especially the smaller ground-nesting birds, have been severely damaged by rats, cats and pigs, and indirectly by the destruction of the habitat by grazing mammals. No endemic flightless land-birds have survived on any island into which cats or rats have been imported, and on no island has the ground nesting petrel population remained large after the establishment of these animals.

Disturbance of the native vegetation by man and his stock has greatly assisted the spread of alien plants. In some cases these could probably establish themselves even in undamaged communities, but there is no doubt that grazing and burning contribute greatly to the wholesale replacement of indigenous species by imported ones.

In general, therefore, it is evident that island floras and faunas are far more vulnerable to human interference than those to be found in a continental region of comparable terrain and climate. To a large extent this reflects their isolation and consequent species-poverty; their simple ecosystems are far less well 'buffered' against change. It is also evident that if such native floras and faunas are to be preserved for scientific study almost all normal human 'farming' activities must be excluded. Grazing and predatory mammals are totally incompatible with natural island ecosystems, and even the cultivation of vegetables inevitably increases the rate of establishment of alien plants through the impossibility of guaranteeing weed-free seed.

There are now only a few southern islands which are sufficiently undamaged to be worth preserving by such rigorous measures, which must inevitably impose added discomfort on the personnel of weather stations and other bases established there. Nightingale, Inaccessible, and especially Gough Islands in the Atlantic; Prince Edward Island, the Îles Crozet, and some of the smaller outliers of the Îles Kerguelen in the Indian Ocean; and some of the outlying islets in the New Zealand sub-Antarctic groups alone fall into this category. In the other islands research should aim at recording as far as possible the native floras and faunas before they are lost, and studying the natural experiments that are going on through the activities of introduced species.

Table 2. *A summary of human influence on certain southern islands*

Man	Animals introduced by man (those now extinct on the island in parentheses)	Native animals now extinct on the island, or much reduced (those extinct in parentheses)	Aggressive introduced plants (i.e. spreading into native vegetation)	Native plants now extinct or much reduced (those extinct in parentheses)
Tristan da Cunha 1506 discovered; thereafter visited; 1790's sealing gangs ashore; 1810 settled. (Present population about 300.)	(Before 1790—goats) (Before 1810—pigs) *c.* 1810—cats Before 1824—cattle Before 1824—dogs Before 1824—sheep Before 1824—poultry (Date unknown)—mice Before 1867—donkeys 1882—rats	(*Arctocephalus gazella*) *Diomedea chlororhynchus* (*D. exulans dabbenena*) *Eudyptes crestatus* (*Macronectes giganteus*) (*Mirounga leonina*) (*Nesospiza achunhae achunhae*) *Phoebetria fusca* (*Porphyrionis nesiotis*) *Procellariideae*	*Agrostis stolonifera* *Anthoxanthum odoratum* *Cerastium caespitosum* *Holcus lanatus* *Poa annua* *Rumex acetosella* *Sonchus oleraceus*	*Phylica arborea* (*Poa flabellata*)?? *Spartina arundinacea*
Nightingale Island 1506 discovered; thereafter visited; now visited annually by Tristan islanders	None recorded	*Arctocephalus gazella* *Mirounga leonina*	*Holcus lanatus* *Poa annua* *Sonchus oleraceus*	None recorded
Inaccessible Island 1506 discovered; visited thereafter, several shipwrecks; 1871–73 two residents; 1938 abortive farming	(Between 1882 and 1883—pigs) (Between 1882 and 1883—goats) (1938—sheep) (Occasionally—dogs)	*Arctocephalus gazella* *Diomedea exulans dabbenena* *Eudyptes crestatus*? *Mirounga leonina*	*Aira caryophyllea* *Cerastium caespitosum* *Poa annua* *Sonchus oleraceus*	None recorded
Gough Island ?1505 discovered; visited occasionally thereafter, shipwreck recorded in 1867; 1955 weather station established	Before 1887—mice 1956—poultry 1956—sheep (1958—goats) 1959—dogs	*Arctocephalus gazella* *Mirounga leonina*	*Agrostis stolonifera* *Holcus lanatus* *Poa annua* *Sonchus oleraceus* *Rumex obtusifolius*	None

Man	Animals introduced by man (those now extinct on the island in parentheses)	Native animals now extinct on the island, or much reduced (those extinct in parentheses)	Agressive introduced plants (i.e. spreading into native vegetation)	Native plants now extinct or much reduced (those extinct in parentheses)
Macquarie Island 1810 discovered; sealed intensively thereafter by gangs living ashore; 1948 weather station established	*c.* 1820—mice *c.* 1820—rats *c.* 1820—cats (Before 1821—dogs) *c.* 1880—*Gallirallus australis* *c.* 1880—rabbits (Before 1923—horses) (1947—goats) 1947—sheep	*Arctocephalus forsteri* *Aptenodytes patagonicus* (?*Anas gibberifrons*) (*Cyanoramphus novaezelandiae*) *Diomedea exulans* (*Hypotaenidia philippensis*) At least nine species burrowing petrels	*Cerastium triviale* *Poa annua* *Stellaria media*	*Pleurophyllum hookeri* *Poa foliosa* *Poa hamiltonii* *Polystichum vestitum* *Stilbocarpa polaris*
Campbell Island 1810 discovered; *c.* 1890–1927 settled and farmed; 1908–14 whaling and sealing visits	*c.* 1890—sheep (1883—goats) (1883—pigs) (1883—rabbits) (?—game birds) (?—guinea fowl) Before 1883—rats	*Arctocephalus forsteri*	*Cerastium vulgatum* *Poa annua* *Sagina procumbens* *Stellaria media*	*Danthonia flavescens* *Pleurophyllum hookeri* *Poa foliosa* *Poa litorosa*
Auckland Island 1806 discovered; 1841–56 settled; occasional stock-raising attempts later	1807—pigs (1849—cattle) (?—sheep) Before ?1866—goats ?—cats (1895—cattle) Before 1866—rabbits	*Arctocephalus forsteri* (*Hypotaenidia muelleri*) *Nesonetta aucklandica* Many ground nesting birds { Rose and Enderby Islands only		*Danthonia* ? *Poa foliosa* ? *Stilbocarpa polaris*
Kerguelen 1772 discovered; thereafter whaling and sealing visits; 1908–14 and 1921–32, shore-based whaling and sealing; 1949 base established (110 men in 1960)	Before 1874—mice Before 1874—cats 1874—rabbits Before 1900—rats ?—dogs (doubtful) 1909—sheep 1949—mules 1950—pigs 1950—horses 1950—cattle 1955—reindeer	*Arctocephalus gazella* *Calcopteryx moseleyi* *Mirounga leonina* And probably many species of penguins and other sea birds breeding on the island	*Cerastium glomeratum* *Myosotis versicolor* *Poa annua* *Sagina procumbens* *Stellaria media* *Taraxacum* sp. (?*erythrospermum*)	*Azorella selago* *Lyallia kerguelensis* *Poa cookii* *Pringlea antiscorbutica* And *all* vegetation where rabbits most abundant

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THE CONSTRUCTION AND USE OF KAYAKS IN NORTH-WEST GREENLAND: PRELIMINARY REPORT

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[*MS. received 10 February 1961.*]

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Introduction

This paper is a report on the preliminary work of a long-term study of the construction, use and cultural significance of kayaks among Greenlanders living in the Úmánaq area of north-west Greenland.

The author spent from mid-August to late October 1959 at the outpost Igdlorssuit, in this area. Igdlorssuit (lat. 71° 14′ N., long. 53° 30′ W.) is a village of 110 Greenlanders and is one of seven outposts and two dwelling-places grouped around the town of Ũmánaq (population 747). The total population of the area is 1865. It has its own church, school, and store, with a catechist-cum-school teacher and a trade post manager, both Greenlanders.

The principal aim of the visit was to observe and photograph the techniques of kayaking and seal hunting by kayak in this region.

The region, well within the Arctic Circle, has a short but warm summer, the period of midnight sun extending from early May to the beginning of August. Into it discharge two of the four major glaciers of the west coast, producing a large number of icebergs throughout the summer. The winter sea ice, which covers the waters of the entire area, lasts for 6 to 7 months, dispersing rapidly in early June.

The author took with him his own kayak-type canoe which he had designed, constructed, and used for cruising on the west coast of Scotland during the years 1952 to 1958. In this kayak he took part in, photographed, and observed the various aspects of summer seal hunting.

On arrival at Ũmánaq he spent a week at another outpost in the district, Ikerasak, as the guest of Bent Jensen, a Danish student of Eskimology. With Bent Jensen, a start was made in learning Greenlandic and points of custom and etiquette. While at Ikerasak, a visit was made to Ũmánatsiaq, a neighbouring dwelling-place, where a systematic recording of constructional details of the kayaks, and data of hunting equipment, was carried out. This proved a useful basis for later work in Igdlorssuit.

The life of the villagers is still basically that of the traditional north-west Greenland hunting culture. The main object of the hunt is the seal, there being five species found in the area. These are the Ringed Seal (*Pusa hispida*), the Harbour Seal (*Phoca vitulina*), the Harp Seal (*Pagophilus groenlandicus*), the Bearded Seal (*Erignathus barbatus*), and the Hooded Seal (*Cystophora cristata*). Of these, the Ringed Seal is very much the most common. Seal are hunted during the winter by harpoon and rifle at the breathing holes, by netting, and in the spring by the shooting of sleeping seals lying out on the ice. All travel on the sea ice is by dog sledge, with teams of six to eight dogs harnessed in "fan-trace" arrangement. In the summer season, of 5 to 6 months' open water, seal are hunted from the kayak.

In this way the villagers obtain their main item of diet, seal meat, some portions of which are still eaten raw. The skins, half-cured, they can sell to the village trade post, or retain for their own use in the making of clothing and equipment. The traditional seal skin boots are almost universally worn and for kayaking and most heavy work the men still use seal skin trousers. The short trousers and thigh boots of the women's gala dress are also of seal skin. Many, though not all, of the kayaks are skin-covered, and much of the hunting gear for kayak and dog sledge requires the use of seal skin. The skin of the Ringed Seal is used for trousers, boot uppers and certain of the kayak and sledge accessories. The skin of the Bearded Seal is used for thonging, e.g. dog whips, dog traces, harpoon line; and that of the Harp Seal for boot soles and the skinning of the kayaks.

Construction and appointments of kayaks

At Ikerasak, Ũmánatsiaq, and the outpost Qaersut, also visited before arrival at Igdlorssuit, a number of kayaks were borrowed both for kayak rolling and general use. In Igdlorssuit itself, a detailed study of construction and hunting equipment of all kayaks was made, and hunting methods, kayaking techniques, etc. were noted. A number of the villagers' kayaks were borrowed for further use and comparison. The techniques of harpoon throwing and kayak-rolling were practised, and recorded. Safety factors were noted and methods of rescue and assistance were demonstrated.

The number of Harp Seal caught is insufficient for all kayaks to be covered with seal skin and in many cases canvas has to be used. In Ũmánatsiaq, all eight kayaks were canvas covered, and in Igdlorssuit one of the eighteen. All canvas-covered kayaks observed were painted white, as were also seven of the skin-covered kayaks in Igdlorssuit. The canvas-covered and painted kayaks offer the best possible camouflage, but the canvas, being less strong than seal skin, cannot withstand the scraping of the first thin sea ice forming in the early winter.

A completely equipped kayak (*qajaq*) as observed, had the following items of hunting gear. The sealing harpoon (*unâq*) with its detachable throwing stick (*norssaq*) on the right side-deck; the kayak stand (*asatdlut*) on the fore-deck; on which lies the coiled-up harpoon line (*aleq*) with the harpoon head (*tũkaq*); the sealing float (*avataq*), the inflated skin of a young Ringed Seal, on the after-deck; the hunting knife (*qajarmioq*) on the right fore-deck; the white screen (*tâlutaq*) near the bow; the killing lance (*anguvigaq*), or more often a winter ice-pick (*tôq*), on the left after-deck, used to steady any small seals or other loads carried on the after-deck; and the towing straps (*kalutit*) kept inside the kayak. These various accessories are held in place by deck thongs (*tarqat*) of seal skin (Bearded Seal). A small keel-fin (*aqût*) is attached near the stern. All the kayaks observed were fitted with a sleeve, or sheath (*pôrtaq*) of Ringed Seal skin to hold rifle and shotgun in addition to the more traditional hunting equipment. This lies on the fore-deck under the "kayak stand". The double-bladed wooden paddle (*pautit*) is about 5 in. broad.

The kayaks are kept on wooden racks (*qáinivît*), some communal, some individual, raised out of reach of the dogs. In this part of Greenland the dogs roam loose around the villages and are never tethered in any way. The kayaks generally lie in upright position with a cover over the manhole, with all the hunting gear in place. They are lashed down as a precaution against strong winds.

A hunting kayak, typical of those used in Igdlorssuit, was made to the author's measure by one of the Igdlorssuit hunters. The all-wood framework was completed by this man, working alone, in 6 days. The split wood for the bent frames, the hoop for the manhole coaming, and the common joiner wood used for all other portions of the framework, were bought from the village store, all being imported from Denmark. The main strength of the skeleton itself lies in the gunwales and deck spars, mortised and tenoned together. Certain of the spars are tied in place with cord. The ends of the bent frames are loosely socketed into the underside of the gunwales, and in no way secured: in due course the skin of the kayak holds these in place. The keel strip and two stringer strips are attached to the frames by steel pins. The carefully shaped bow and stern pieces are tied by cord to the gunwales, and nailed to the keel strip. The stringer strips are left unattached at bow and stern. These stringers are so attached to the bent frames that they lie in a continuation of the plane of the gunwale sides, which gives the finished kayak its inclined flat sides. The bottom of the kayak is almost flat. The resulting cross-section of "hard chine" form, gives the kayak a stability greatly in excess of wha might be expected of so narrow a craft.

The skinning of the kayak is a woman's job, six women working for on day to complete it. The four Harp Seal skins to be used are depilated and soaked in sea water for 2 days to render them entirely soft. They are then sewn together and trimmed to the total length of the kayak. At each end th skin is sewn into sheaths, or pockets, about 12 in. long, and these are fitte over the bow and stern pieces of the framework. The skins are tightly lace with cord over the hull, and those along the centre of the decks are sewn Finally the manhole coaming, which is not fixed to the framework of the kayak is worked into place. This is done by the skin of the kayak being stretche over small bone pegs inserted around the rim of the hoop. All sewing in th skinning of the kayak is with double seams, the stitches only half penetrating th skin. In this way a remarkably watertight seam is achieved. On drying ou the skin is tightly stretched over the frame. The deck thongs with their variou bone toggles are tightly lashed in place, the bone nipples on bow and ster are added, a strip of bone to protect the keel at the bow is attached, and th kayak is complete.

The various items of hunting gear were also made for the author's kayak which was finally complete in every respect, but for the body towing strap, and the harpoon line. This kayak has been brought back to Europe for further practice and experience.

Preparation for use

The launching of the kayaks observed was from the village beach at Igdlorssuit and Qaersut, and from rock ledges at Ikerasak, Ũmánatsiaq, and Nûgâtsiaq. In the latter method the kayaker steps into his fully floating kayak, which is steadied by the paddle being held at right angles to the kayak. One blade is wedged under the thongs of the fore-deck; the free blade, being thus some 5 in. submerged, restrains the kayak from any tendency to capsize. The kayaker sits down on the after-deck and, with a pull on the fore-deck thongs, forces himself into his seat, a folded sealskin on the floor of the kayak. Where the launching is done from a beach, the kayak is placed half in, half out of the water pointing to the shore, in order that the keel fin, near the stern, may be clear of the bottom. When ready the kayaker is generally helped by someone at the bow easing the kayak fully into the water; if necessary, however, a kayaker can manage alone.

When hunting by kayak the hunters generally wear a white anorak and white topped cap, to add to the camouflage of their white painted kayaks and the white screen. To an unwary seal the hunter presents the same appearance as a lump of floating ice. A waist band of Ringed Seal skin, reaching almost to the armpits, is worn to prevent water washing into the manhole; this is the "half-jacket" (*tuvîtsoq*). The "full-jacket" (*tuvilik*) was only seen used in practising kayak rolling. This is also of seal skin, fitting tightly around face and wrists, and the rim of the manhole. Mittens (*ârqatit*) of Ringed Seal skin were used in the autumn.

Rolling a kayak

Kayak rolling (*kíngussaqátârneq*) is the technique by which a kayaker on capsizing is able, by allowing the kayak to go fully upside down, to bring himself upright on the other side by making a special sweep of the paddle and body. The risk of capsize in rough weather, from a sudden violent disturbance of the water caused by the breaking of an iceberg, or by the attack of a wounded Hooded Seal, can never be discounted. Thus a knowledge of kayak rolling is a virtually essential safety precaution. The average dimensions of the kayaks observed in Ũmánatsiaq and Igdlorssuit were approximately 16 ft. 9 in. length, 19½ in. beam, and 7 in. draught, dimensions well suited to rolling. Of the eighteen active kayakers in Igdlorssuit, thirteen could roll and most of them by a number of methods. Five kayakers could not roll, of these two were young hunters who had only been kayaking for one or two seasons. The six older men in the village, who no longer kayaked, were all skilful kayak rollers in their younger days.

The basic kayak rolling technique observed is that in which the roll is begun with the paddle blade held on the surface of the water near the kayak's bow. The necessary purchase is obtained from the lift provided by sweeping the paddle across the surface of the water, through an arc of at most 90°. A skilful roller will only need to sweep the paddle through 25–30°. There are two common methods of holding the kayak half capsized, with the body in the water, by gentle sculling action of the paddle. This position can be maintained for perhaps a minute or more, with the face clear of the water. A firm pressure on the paddle restores the kayaker to an upright position.

At different times four of the Igdlorssuit hunters demonstrated kayak rolling. One of these four was the best kayak roller in the village and demonstrated fourteen methods; this was the greatest number observed. One man could roll with the paddle held under the keel of the kayak and also with the throwing stick alone, these in addition to the more orthodox methods. There were three men who could roll by more than ten methods. There are altogether seventeen methods known in Igdlorssuit. Certain methods used in neighbouring districts were also described. These are rolling with the harpoon as done in the Upernavik district to the north of Ũmánaq, and rolling with the hands alone, the two hands being held together, which was done by one man in the outpost Sarqaq in Disko Bugt. In all there are twenty-one methods in current use in and around the Ũmánaq area.

Hunting by kayak

A part of the traditional Eskimo hunting culture was the establishment of hunting camps during the summer beside waters in which the seals were plentiful. Whole families with all their possessions would spend the summer living in skin tents, sometimes at considerable distance from the permanent winter dwelling place. The villages are nowadays permanent abodes the year round. Although communal houses are now a thing of the past, the various villages of the area show a variety of types of one family house. These range from the traditional type of a single-room dwelling with stone and turf walls some three or more feet thick and a flat roof, to the modern all-wood, pitched roof, Danish style of two-, or more, roomed house. There are also many of composite type, having the traditional turf walls covered by a wooden pitched roof enclosing a storage loft. Apparently on account of the possession of these relatively valuable houses and the presence of the village trading posts, the old practice of setting up summer hunting camps has been almost abandoned.

Now if the waters around the village are not visited by the seal, there is a possibility of the people going short of meat. During the author's stay in the village, while the hunters were regularly kayaking in search of seal, only one Ringed Seal was caught by a hunter based on the village. All other seals were caught by men who had taken their kayaks with them when visiting their shark lines by motor boat. In September two weeks passed without a single seal being caught.

In villages where they are owned, it is common for three or four men together to make week-long hunting trips by motor boat. The author joined three men on such a trip. Kayaks and camping gear were carried on board the boat, a 20 ft. inboard motor boat with "Dan" motor, owned by two brothers. The trip was of 6 days into the Karrats Isfjord, 34 miles to the north-east of Igdlorssuit. A small canvas tent was used and four camps made in the course of the trip. The hunters made two trips every day by kayak, each of about four hours. The second trip of the day was generally in the afternoon, when the light would be too poor for photography. The author, in his Scottish kayak, therefore accompanied one of the hunters on the morning trip, begun before dawn, and was able to observe and photograph the seal hunting from the closest possible range.

The technique observed was to stalk the seal, crouching low and motionless behind the white screen whenever it turned in the direction of the hunter, until within range of a shotgun. The seal, if alarmed, can dive and swim so far as to be out of sight to the hunter on its next surfacing for breath. In stalking, the hunter depends on the camouflage afforded by his white anorak and head-gear, the white screen on the bow, and, in some cases, the white painted hull of the kayak. Under ideal conditions with seal straight ahead, and unalarmed, the hunter has a good chance of being able to approach within range of shotgun, or even harpoon. The recoil from a shotgun is sufficient to capsize the kayak, so a seal can only be shot when straight ahead. The chances of the seal surfacing directly ahead are, of course, remote and many escape. Often the seal is first seen from a considerable distance and then, while it is submerged, the hunter will approach to where he gauges it will next appear. If a relatively thin seal is killed with the rifle it may sink too quickly to be harpooned, and thus be lost. For this reason the seal is always wounded first with the shotgun and can then more readily be approached and harpooned from close range. This may not always be easy. On one occasion a good hour was spent before the seal could be secured, although already four times shot by shotgun.

The harpooning of the seal is the most essential feature of this hunting technique. The 7 ft. harpoon, with harpoon head in place on the 10 in. bone foreshaft, lies ready on the side-deck, pointing astern, with the throw stick uppermost. At the moment of harpooning the hunter lifts his paddle well clear of the water and raises the harpoon high, this rotating it to point forwards. Leaning well back he vigorously hurls the harpoon, holding only to the throw stick which hinges free to act as an extension of his arm, giving added force and control to the flight of the harpoon. The striking of the seal, and the seal's immediate dive, combine to break free the foreshaft, on its loop of thong, releasing the harpoon head and allowing the wooden shaft to float clear. The harpoon head, of toggle form, swivels round to give a firm anchorage to the 40 ft. line with its inflated float. The hunter, his throw stick quickly taken between his teeth, throws the sealing float out to the side of the kayak as the diving seal jerks out the coiled line. Thus harpooned, the seal cannot escape and can be recovered when dead, even in the event of its sinking. Once it has been harpooned the capture of the seal is certain. It is killed with one shot of the rifle and towed back to camp.

First of all the dead seal is pulled to the side of the kayak, and the harpoon head removed. Two towing straps are attached, one to the cheek and the other to the belly, by means of small incisions in the skin. The cheek strap is a long skin thong with a bone toggle at each end, one of which serves as a handle, and the other as a wedge in the eye opening. Part way along the strap is another bone toggle, which is wedged under the end of the fore-deck thongs. The effect of this is to turn the seal on its back and to hold its head tightly against the side of the kayak. The body strap has similar toggles at each end, and a small bladder (*avataussaq*) midway along its length. The toggle on the body strap, holding the seal against the side of the kayak, is a 9 in. bone pin which is slipped under the after-deck thongs, pointing forwards. The seal is then released to float, supported by the body strap bladder, while the hunter re-arranges the harpoon, harpoon line and other items of his hunting equipment. Then the seal is recovered and attached to the left side of the kayak ready to be towed home. By this method of attachment, one sharp pull will release the toggle of the cheek strap, while the drag of the seal's body will free the toggle of the body strap, and the body will float free, supported by the body strap bladder which also acts as a marker. The hunter can thus rid himself of the encumbrance in case of emergency, or in order to stalk another seal.

Should a hunter kill more than one seal, the bodies are all towed on the left side of the kayak, one fastened behind the other, with only the first seal attached to the kayak. The skinning, back in the village, is a woman's job. For this the women's knife is used, with toggle hand-grip of bone, and crescent-shaped blade. During the hunting trip the men skinned only those seals necessary to maintain the daily supply of meat. This was invariably eaten boiled, with the exception of certain portions, in particular the liver, which was eaten raw on the initial cutting open of the seal.

Two nights were spent at Umiámáko, the point of land separating the Rinks Isbræ from Umiámáko Isbræ. Here they joined a hunting party of twelve men from Nûgâtsiaq, who had travelled by kayak as these villagers had no motor boats. This provided an admirable opportunity to observe a sizable party of hunters engaged in their traditional summer seal hunting away from the more Europeanized village environment. During the 6 days of the trip, two short visits were paid to Nûgâtsiaq, the most northerly village in the area.

In the course of the trip eight Ringed Seals were caught by the Igdlorssuit hunters, while twenty-six others were seen, but escaped. Two Harp Seals were among those caught by the Nûgâtsiaq hunters at Umiámáko. The author observed the killing of four seals, and the unsuccessful stalking of six. During the stay in Igdlorssuit, one Bearded Seal and a number of Ringed Seal were caught by men out by motor boat to inspect the shark lines.

Future studies

During the coming years it is intended to continue this preliminary investigation to cover the entire Ũmánaq area in a detailed and systematic study of all aspects of kayaks and kayaking. It is to be a joint project by Bent Jensen and the author, and will form part of Bent Jensen's long-term study of the social life and its Eskimo background in the Ũmánaq area.

INSECT HABITATS IN ANTARCTICA*

BY J. L. GRESSITT AND R. E. LEECH†

[*MS received 4 October 1960.*]

About fifty species of terrestrial arthropods have been collected in Antarctica;[1, 2] these include mites, ticks, springtails, sucking lice, biting lice and flies. The mites include both free-living and parasitic forms, the springtails and flies are free-living, and the ticks and lice are parasitic. The ticks, parasitic mites, and biting lice are associated with birds, and the sucking lice with seals. The number of species are about equally divided between free-living and parasitic forms. The ability of insects and mites to survive the very low winter temperatures and frequent strong winds of Antarctica is of considerable interest; judged in relation to commonly accepted ideas of tolerance, the environment is extremely forbidding.

The parasitic forms, of course, are dependent upon their hosts for their dispersal, and they benefit from the hosts' body warmth. Studies at Macquarie Island on a sucking louse parasitic on the Elephant Seal showed that the temperature of the host's skin in the sea ranged from 10 to 12·5° C.; the sea temperature was 8·5° C.[3] Such studies have not yet been made in the true Antarctic, where the sea is much colder and where the seals spend most of their non-feeding periods lying on ice. Yet Weddell Seals infested with sucking lice have been taken south of Cape Armitage, in lat. 77° 54′ S., near to the southernmost limit of their range.

The free-living arthropods in Antarctica are found in many situations, including brackish and freshwater ponds, snow-melt streams, old lava flows, scree slopes, moraine deposits (including moraine on moving ice), exposed basalt, marble, sandstone and other rocks, and soil when present. Insects have been found in Antarctica from sea level (at Marble Point, in lat. 77° 25′ S., and the foot of Mount Discovery, in lat. 78° 18′ S., by Gressitt), to 1,650 m. (in lat. 72° 17′ S., in Dronning Maud Land, by Wilson), and from 150 to 600 m. at the southernmost points recorded[5] (near Beardmore Glacier in lat. 83° 55′ S., by C. H. Tyndale-Biscoe). In general, free-living insects and mites are associated with plants, but sometimes the association is not obvious. The plants found in most areas of exposed rock in Antarctica are algae, lichens and mosses. In certain more northern areas, such as Graham Land, fungi, liverworts, and grasses occur. More species of insects are found in such places. However, the plants, particularly lichens, seem to be more tolerant than the insects, and are often found without insects. On Thurston Peninsula (Island), and nearby islets, in lat. 71° to 72° S., Leech found plants but no insects, but the time ashore was extremely limited.

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* Partial results of work under the U.S. Antarctic Research Program, supported by a grant from the U.S. National Science Foundation.

† Bishop Museum, Honolulu.

In favourable environments, both mites and springtails may be found in great numbers. Lice on the penguins, skuas and seals in McMurdo Sound occurred in very small numbers, requiring much searching of the feathers or fur.

Despite the variety of environments inhabited by insects, they are not necessarily to be found in all places free of ice or snow during the summer. Many areas are too dry, too exposed, too cold, or are otherwise unfavourable. Presumably nearly all areas populated by insects are covered with ice and snow in winter. In some such places only thin, or temporary, snow or ice cover is maintained. The strong winds which generally blow on the continent clear the snow from many capes, ridges, steep slopes and similar topographic features and expose the substratum, at least during part of summer. Certain valleys are free of ice and snow and have no available moisture on their floors. This may be the result of temperature increase caused by increased pressure of winds from more than one source, or the result of winds keeping the precipitation confined to the surrounding mountains and the sublimation of snow in the dry air of the lower parts of the valleys. In these valleys, such as the Taylor Glacier Dry Valley (visited by Leech), the Wright Glacier dry valley, and Victoria Valley (visited by Gressitt) of the Victoria Land coast near Marble Point, the floors are generally too dry to support insect or plant life. These are the valleys where 1,700-year-old mummified seal carcasses are found.[4]

Environments favourable to insects are generally exposed to the sun; northward-facing slopes are consequently most suitable. In addition to proper exposure to the sun, some protection from wind is helpful, but probably not so critical. Moisture, and food in the shape of algae and mosses, are of great importance. Where the substratum is dry for any protracted period, insects are not likely to survive. Varying degrees of dampness can be tolerated, but there is considerable local migration from drier to damper areas, or from wet to slightly less wet areas, as local circumstances change with the season. In general, the insects are dependent upon the melting of snow or ice. Thus the populations tend to be on slopes which receive seepage water from permanent ice, or accumulations of ice or snow which last much of the summer. If the areas do not remain damp from seepage, the insects may move up the slope as the ice recedes to keep within the damp zone; if they do not move, they may die.

There is evidence that insects are distributed locally by winds as springtails were taken in air nets over land and water.[6] If Antarctica was formerly still more ice-covered than it is now, the ancestors of the present free-living fauna may have immigrated in air currents from other continents or sub-Antarctic islands. There is also other evidence of local dispersal and much ecological data is shortly to be reported.

Among the favourite niches of mites are the undersides of smooth-bottomed, loose, usually small, rocks, often of shale, lying on alluvial soil or near the beds of temporary streams where melt water flows or seeps during the warmer part of the day. The rocks do not always bear evident plant growth, but there are generally at least algae in the ponds, streams, or damp soil nearby, or

Lichen growth from a nunatak in Hood Glacier, Ross Dependency. Both collembola (*Xenylla* and *Anurophorus*) and mites were found

Black springtails (*Gomphiocephalus hodgsoni*) on underside of volcanic rock at Cape Royds, Ross Island, with white moulted skins. Adults about 1 mm. in length

Photographs by C. H. Tyndale-Biscoe

(*Facing p.* 502)

lichens on some rocks. Another common niche for mites is provided by cavities in porous volcanic rock, like the kenyite at Cape Royds, Ross Island, or scree slopes on Observation Hill, Cape Armitage, Ross Island. At the foot of Mount Discovery, in lat. 78° 18′ S., mites were found under small rocks on a slope of loose moraine, on moraine and ice hills moving because of pressure from a glacier, and the edge of the Ross Ice Shelf. Algae were present, but no lichens were seen close by.

Springtails are found in similar environments, but seem not to be quite so widespread or tolerant as mites. Occasionally both mites and springtails can be found under the same rock. They are often found in numbers under stones bearing lichens, and in favourable weather they may be found crawling about on the exposed surfaces of lichen-bearing stones or rock outcrops. They seem to prefer slightly damper situations than do many of the common oribatid mites. Springtails are also common among moss roots, whereas mites seem to be rarer there.

The wingless chironomid fly, *Belgica antarctica*, of Graham Land, in lat. 65° S., long. 62° W., breeds in brackish coastal water.[7] The winged chironomid fly, *Podonomus steineni*, in the South Shetland Islands also breeds in brackish water. Leech found it at the water's edge in the crater hole on Penguin Island, in lat. 62° 05′ S., long. 57° 55′ W. This water roughly maintains the level of the sea, seeping in through the rocks, but is diluted with snow-melt. Torres has described the biology of this species in detail.[8]

Probably all of the free-living Antarctic insects are frozen for much of the long winter period. In summer they are intermittently active, being governed by the temperature in the microhabitat. Although air temperatures a few millimetres above the substratum are almost always below freezing in many of the environments inhabited by insects, the actual rock or other bare surface absorbs heat in the continuous summer sunlight. As soon as the temperature at the surface is above freezing, the insects become active, consequently the direction of exposure permitting maximum absorption of solar heat is probably critical. On days when the sun is obscured, one may overturn rocks with inactive mites or springtails and quickly bring them into activity by exhaling on them.

There does not seem to be any definite season for mating or maturing. Early in the season Leech found several stages, nymphs and adults, under rocks that had just been uncovered from the previous winter's snow. Apparently when the winter freeze-up sets in, the insects turn dormant at whatever stage of development they have reached.

Both mites and springtails have recently been found as far south as lat. 83° 55′ S., by C. H. Tyndale-Biscoe. At this latitude, it is very likely that temperatures during the long sunless winter are below −65° C. for very long periods. It will not be easy to obtain winter temperature records in the type of situation on the nunataks or ridges where these arthropods were found. However, controlled temperature tolerance tests in the laboratory will provide approximate information on the degree of cold which these animals can survive. Some incomplete tests described by Dalenius and Wilson[9] indicated that the lower limit of tolerance of the oribatid mite *Maudheimia wilsoni*, in Dronning Maud Land, in lat. 71° to 72° 17′ S., is between −35° C. and −70° C., and probably close to the latter figure. They also found that considerable development took place at temperatures well below freezing.

Regarding reaction to light, apparently most of the mites and springtails of Antarctica are negatively phototropic. Although they become active when the sun warms the rocks, they prefer to be in darkness under the rocks, at least when the sun is shining.

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After this article went to press, K. A. J. Wise, a New Zealand member of Bishop Museum's team in Antarctica, obtained the highest known altitude record for insects on the continent. This was in the Mount Gran-Willett Range area, in lat. 77° 10′ S., long. 160° E., and the figures were 1830 m. for Collembola and 1865 m. for mites.—*Ed.*

PHOTOGRAPHS OF ANTARCTIC BOTTOM FAUNA

BY J. S. BULLIVANT*

[*MS. received 1 December 1960.*]

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Introduction

During the Antarctic summers of 1958–59 and 1959–60, oceanographic survey work was carried out in the Ross Sea by members of the New Zealand Oceanographic Institute from HMNZS *Endeavour*.[1, 2] Photographs of the sea bed were taken at nine of the forty-nine stations occupied, and at seven of these stations bottom samples were taken with trawls and grabs.

The detailed examination and description of geological, hydrological and biological material collected during the two cruises is in progress. In this article the bottom fauna, shown in representative photographs, is described in terms of the broader taxonomic groups, and unusual features of this fauna are related to peculiarities in the environment.

The underwater photographic equipment used consisted of a 35 mm. Robot camera and electronic flash units enclosed in pressure-resistant, water-tight cases, mounted one above the other in a tripod standing about 6 ft. high (see photograph facing p. 508). The camera was fitted with a supplementary lens to correct for chromatic aberration introduced by the water/air interface, and the shutter was operated by a magnet which approached the camera when the tripod touched the bottom.

A series of exposures could be taken at one lowering if the camera was raised clear of the bottom between each, and time allowed for the flash unit to recharge. If the ship was rolling while on station, an excess of wire had to be paid out immediately the camera touched the bottom, so that the camera was not bounced on the bottom by the swinging boom; while if the ship was drifting in a current, or before a wind, the camera was lifted from the bottom as soon as possible to avoid dragging.

Results

The positions of the stations at which the bottom photographs described here were taken are shown in the sketch map. The fauna shown in the photographs is briefly described below. The field of view of each photograph is approximately 0·75 m. wide in the foreground and 1 m. deep.

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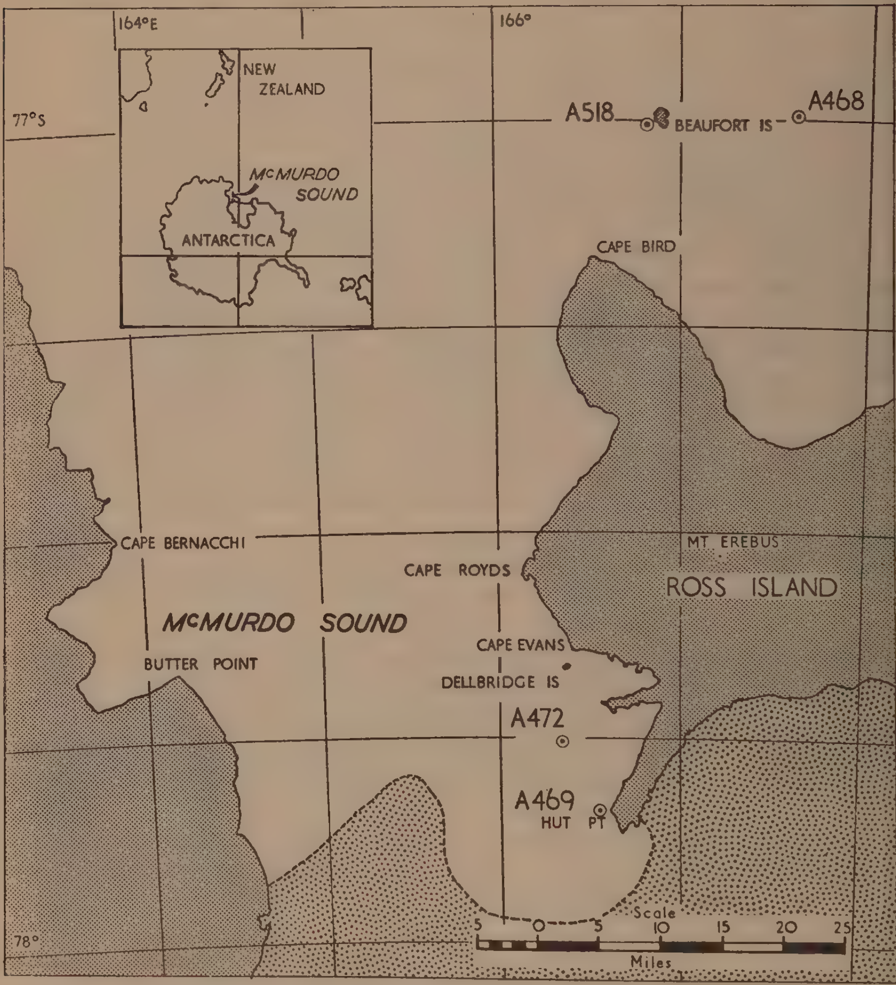
Station A468, 110 *m.*

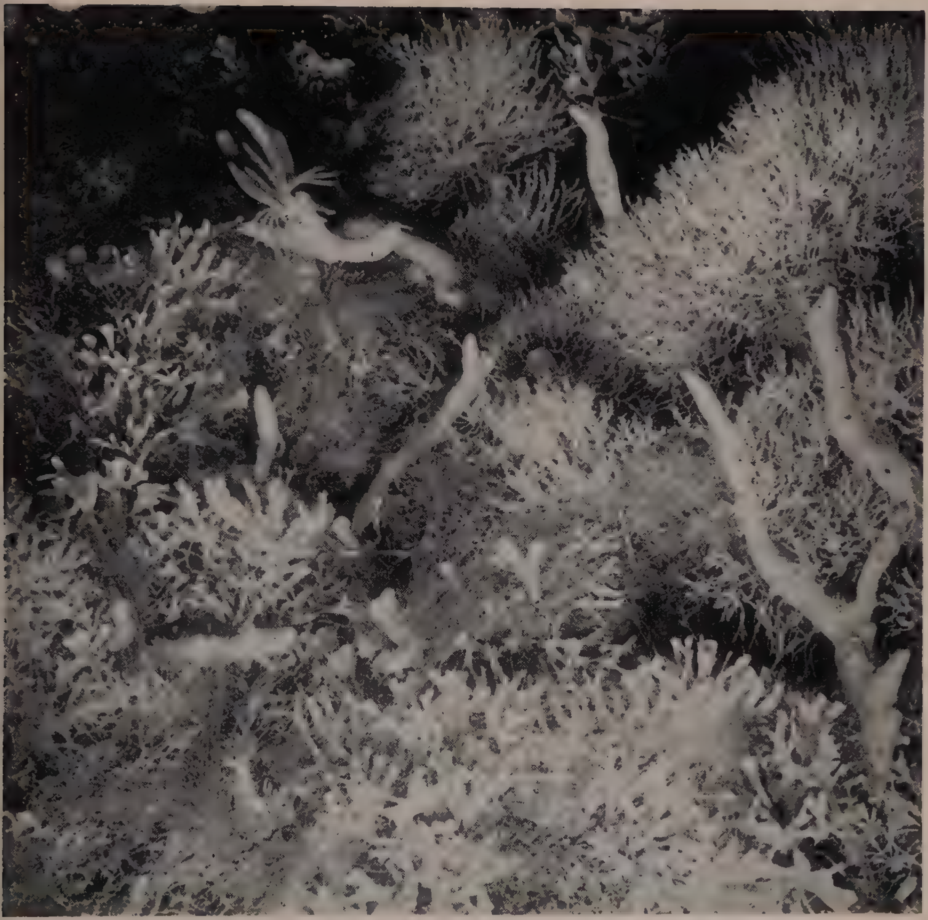
This photograph is one of three taken as the ship drifted across a flat-topped steep-sided seamount, surrounded by water over 350 m. deep. All three photographs show a similar density of animal life composed mainly of sponges, polyzoans and gorgonaceans. In the photograph a crinoid is visible clinging to a sponge upper left, two arms of a starfish extend into the picture top left,



Stations in Ross Sea at which sea bed photographs were taken.

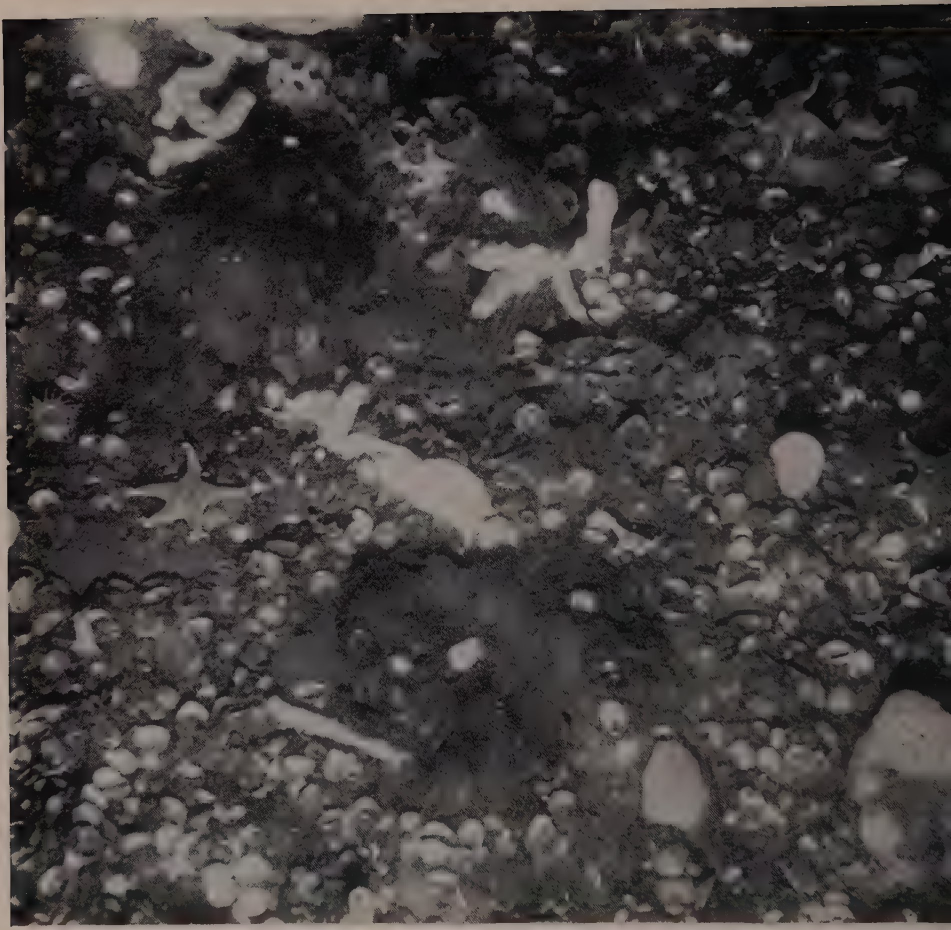
and a small fish may be seen resting on a patch of lamelliform polyzoa top right. The anterior portion of a dendrochirote holothurian is visible lower lef and the expanded tentacles of several tubicolous polychaetes are also visible

A westerly directed surface current of about 1½ knots was noted at thi station and such a current is also indicated in the charts of the area.

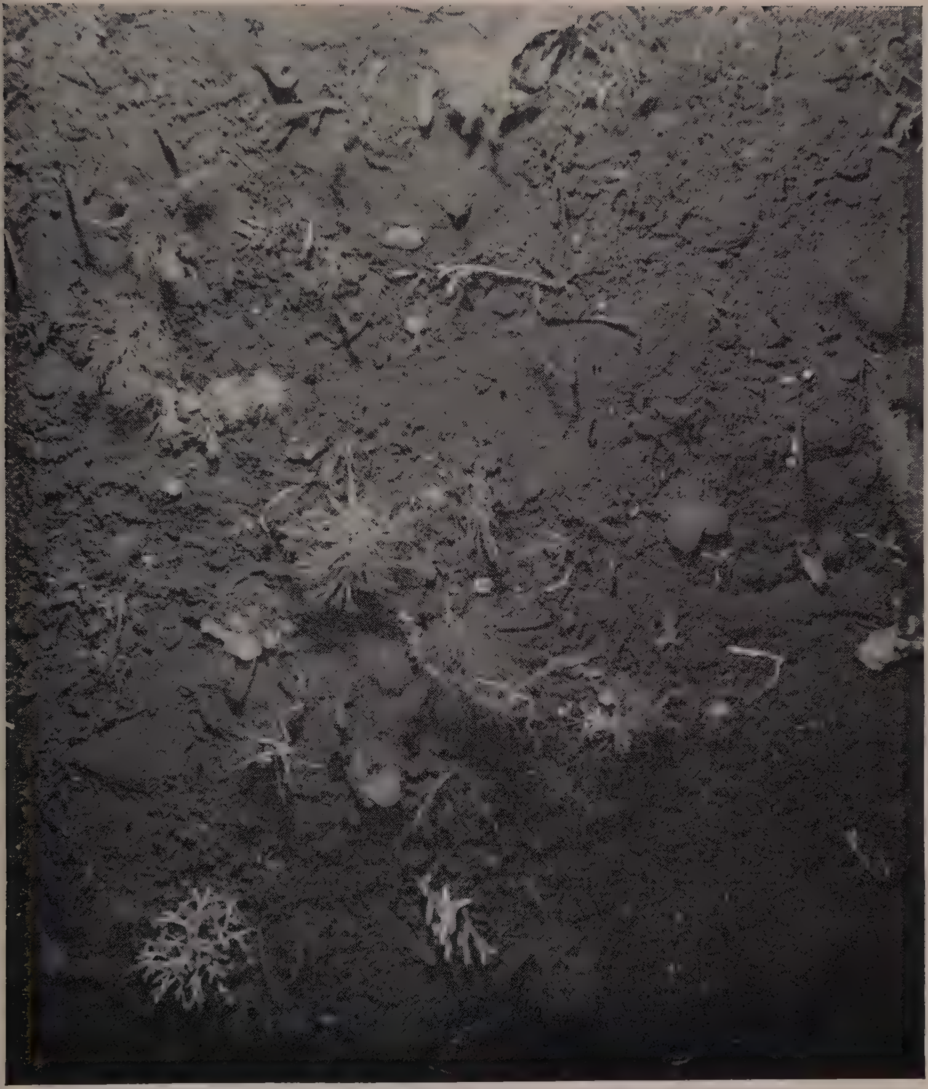


Station A 468. Depth 110 m. A dense growth of filter-feeders

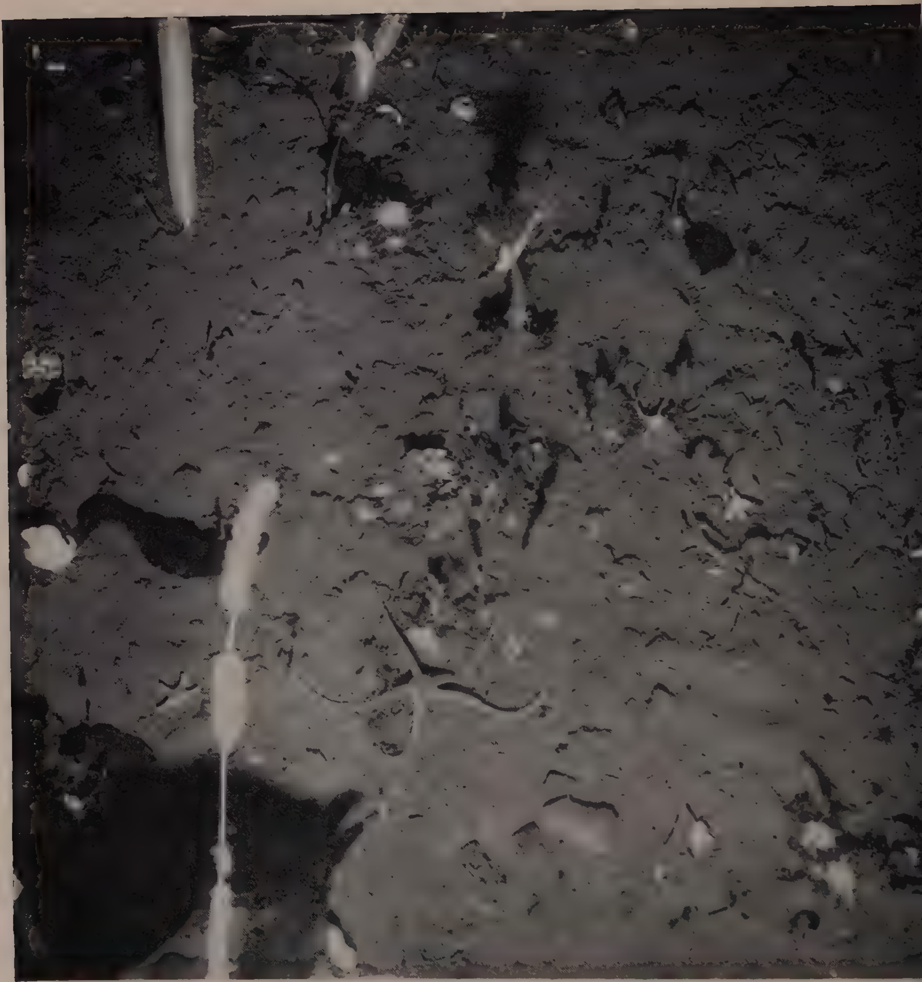
Four photographs of Antarctic bottom fauna, Ross Sea



Station A 469. Depth 64 m. Mollusc shells and starfish predominate



Station A 472. Depth 391 m. Polyzoa, brittle stars and tubeworms



Station A 518. Depth 75 m. Seaweed and sparse mixed fauna

Station A 469, 64 *m.*

When this station was occupied the ship was moored against the ice about 300 m. from Hut Point, in McMurdo Sound. Three photographs were taken at one lowering of the camera. The photographs all show almost the same area and were taken at intervals of about 5 minutes.

Molluscs on the whole are relatively inconspicuous among the Antarctic bottom fauna, but this station was an exception. Most of the shells shown in the photograph are of *Limatula hodgsoni*. The sediment was of muddy sand containing shell and rock fragments and heavily matted with sponge spicules. In the grab samples living specimens of *L. hodgsoni* occupied cavities immediately below the surface of the deposit. A live individual with tentacles extended may be seen in the photograph on the dark patch of deposit below the centre of the picture. In a photograph taken about 5 minutes earlier, the starfish visible to the right and beyond this shellfish is closer to the position of the shellfish, but the latter is not visible—presumably having retracted into its burrow owing to the proximity of the starfish. The common starfish in the photograph is *Odontaster validus*; also visible is another species of starfish, a sea anemone, a species of lamelliform polyzoa, sponges and, bottom right, a trophon gastropod, a pycnogonid and a second species of lamellibranch.

Station A 472, 391 *m.*

This photograph was taken in deep water in McMurdo Sound. Six individuals of a sabellid tubeworm, which is perhaps most easily located by the curved shadow cast by its narrow tube, the tubes of other polychaetes and six species of polyzoa are visible. A gorgonacean extends out of the photograph at left centre. A pipe connexion, dropped from one of the ships moored against the ice above, lies right of centre and it has been suggested by H. B. Fell that the animal immediately below, and to the right of it, is a crinoid. There are about eight ophiuroids present. The bulbous object left of centre may be a group of tunicates.

Station A 518, 75 *m.*

This photograph was taken in the lee of Beaufort Island, just off shore from an Adélie Penguin colony. In density of fauna and appearance of sediment it resembles photograph No. 3, although it comes from shallower water. There are visible in the photograph two ophiuroids, six starfish, clumps of polyzoa and several tube worms. A small echinoid lies lower centre, and below it is what is probably a skeletal plate of a barnacle of the genus *Hexelasma*. The dark mass bottom left, and the similar fragments scattered over the photograph, are probably seaweed. A gastropod is visible on the left. There are three gorgonaceans looking like bottle-brushes and, part of the way up the stem of one of these, a dendrochirote holothurian with tentacles extended is visible.

Discussion

The abundance and variety of animal life on the sea bed adjacent to the continent is in marked contrast to the barrenness of the Antarctic landscape. Unusual features of the environment which may affect the composition of the bottom fauna are the atypical continental shelf, the irregularities of the sea bed produced by glacial erosion and the deposition of poorly sorted ice-borne sediments and, also, the bloom of diatoms in the surface waters during the short summer season.

Most continents are surrounded by a shelf extending out to a change in slope in about 70 fathoms. Such shelves are probably built by coastal erosion and by the deposition of sediment derived from the surface of the adjacent lands. On the evidence so far available, the Antarctic continent, apart from minor exceptions,[3] lacks such a shelf. Instead, in several places around the continent, particularly in the Ross Sea, there has been found a deep fairly level shelf, the edge of which occurs in from 200 to 300 fathoms.

The coast of Antarctica is for most of its length protected from waves by glaciers or pack ice and, because the surface of the continent is almost entirely covered by ice, there is no, what one might call, continental fallout, or river and wind-borne organic and inorganic sediment, to contribute to a continental shelf and to the food of the organisms of that shelf.

The photographs show a predominance in the bottom fauna of animals which feed on particles suspended in the water over the bottom, rather than by ingesting the bottom sediment. Filter-feeding sponges, coelenterates, polyzoans and polychaetes are abundant, while filter-feeding molluscs and echinoderms are also present.

This bottom fauna may be contrasted with that found in Arctic waters where molluscs, polychaetes and ophiuroids usually predominate.[4]

What environmental factors bring about this observed abundance of filter-feeders in the Antarctic coastal bottom fauna? Such factors probably include the absence of organic debris from continental fallout, coupled with an abundance of phytoplankton, and the nature of the sediment, ice deposited mud and rubble which in many places provides attachment surfaces for sedentary organisms.

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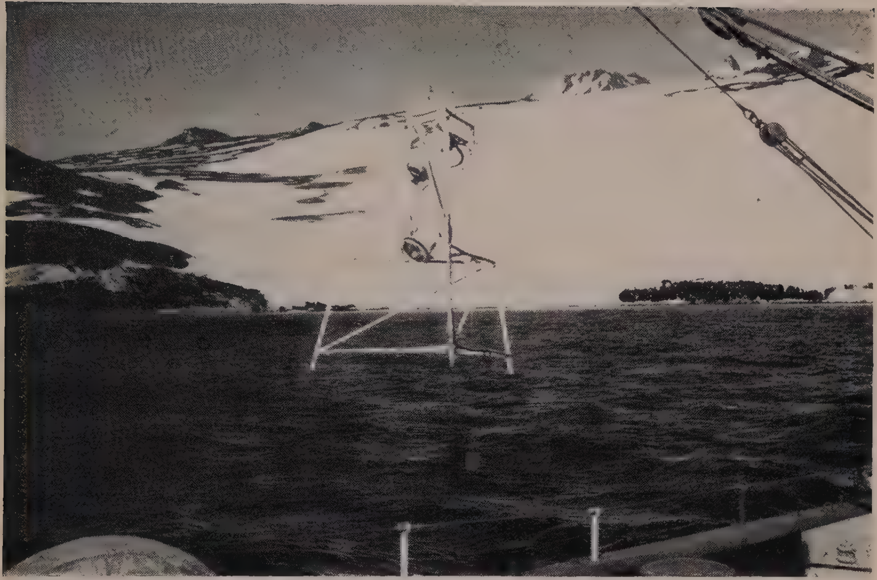

Under-water camera being lowered off Cape Crozier, Ross Island

(*Facing p.* 508)

Pack dogs on upland north of Le Feuvre Inlet,
Prince of Wales Island

PACK DOGS IN THE CANADIAN ARCTIC*

BY A. H. MACPHERSON† AND T. H. MANNING‡

[*MS. received 30 January 1961.*]

Before the Eskimo economy had been much affected by the advent of whites, pack dogs were a common means of summer transport in most if not all parts of the Canadian Arctic. Among the changes which have led to less inland movement in summer are the attraction of settlements at "ship time", the increase in bulk and weight of the average Eskimo family's personal effects, the increased reliance on bought food, the advent of boats and modern weapons, and the decline of the mainland caribou. Also, the availability of steel-shod dog sledges and the increased size of dog teams have, in some areas, made it more convenient to use a sledge in summer than to use pack dogs. However, sledge travel is not suitable for a small party of whites on a single summer trip, as a large team is needed and sufficient dogs and dog food may be difficult to obtain. We have found the use of pack dogs both convenient and economical, particularly for reconnaissance work, where freedom to spend varying amounts of time in any place along the route is a requisite. The reduction of weight of one's personal pack increases the pleasure of travelling and facilitates work along the way. We have used from one to four dogs, depending on their availability and upon the amount of dog food which can be obtained before starting and en route. Five is probably the maximum number of pack dogs that a man travelling alone would want to look after, as loading in the morning and adjusting packs during the day are time-consuming tasks.

The basis for the simpler Eskimo dog packs is the ordinary winter sled harness. Jenness[1] gives the following description of those used by the Copper Eskimos.

> Dog packs were flat sheets of seal skin, oval in outline, and perforated with holes along the two longer sides for cross lacings. Each end was filled like a bag, and the middle section left empty so that it would lie flat on the dog's back. The trace of the harness was drawn down over one side bag, under the animal's belly, and up over the other side bag; it was then pulled taut, and fastened to the end of the harness....

A similar arrangement was seen at Pelly Bay in 1956. However, Eskimo dog packs not unlike those used by us and described below are illustrated by Birket-Smith,[2] and several examples are in the National Museum of Canada.

The packs we have found most convenient are illustrated in the figure, and may be made as follows. The two ends of a strip of 10 oz. duck, 68 in. by 20 in., are folded back to within 8 in. of each other, and the long, side edges lying together are connected by strips of duck about 3 in. wide, which form the front and back edges of the two bags. The ends of a loop of webbing, long enough to slip fairly easily over the dog's head, are sewn on near the top of the inner pair of front seams. The pack is held in place by a two-piece leather girth strap (not shown in the figure) fitted with a strong buckle. The ends of the straps are sewn to the back of the pack well up toward the top, and within 2 or 3 in. of its rear edge. The single pack-cover is a strip of duck, 17 in. by 16 in., with tapes sewn near the corners on the longer edges. The cover is placed over the openings of both bags and the tapes are tied to counterparts sewn to the outer sides of the bags, about half-way up. By tightening these tapes, the bottoms of partially empty bags can be lifted and pulled outward from the dog's legs. We have found that light, waterproof bags made to fit into the sides of the pack are useful in keeping goods dry, in transporting wet articles such as fresh fish, and in making and breaking camp in wet weather.

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* A contribution of the Canadian Wildlife Service, National Parks Branch, Department of Northern Affairs and National Resources, Ottawa.

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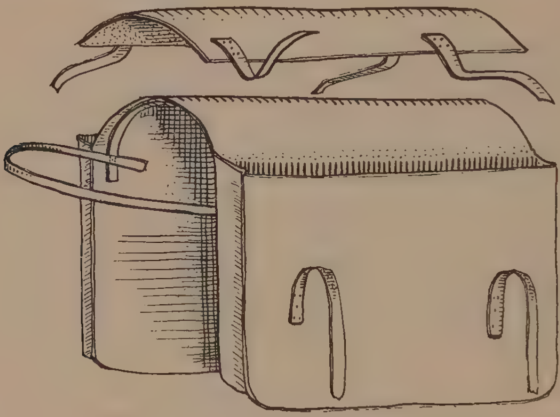

Dog pack used in the Canadian Arctic.

A makeshift pack may be made by sewing up the top of a suitably sized provision or flour bag and making an opening along the centre of one side. A neckpiece can then be attached, or the front of the bag tied to the side pieces of the winter harness. A piece of cord wrapped over the bag and under the dog takes the place of the girth strap. A tent can be carried by simply folding it to an appropriate size, and placing it on the dog's back over the harness, which is then folded back and attached by the trace to the side pieces of the harness near the collar, and bound around the middle. Tent poles may be dragged by attaching one end to the side of the harness.

The bags must be packed with care; the two sides should be balanced for weight and bulk, and no hard angular items should be allowed to chafe the dog's flanks or legs. A small piece of caribou skin, which can be used as a pad under one's sleeping bag at night, is useful for lining the side of the pack facing the dog's flank, and if it is curled around the front and back edges, it will also give some protection to the legs. Heavy items placed towards the bottom of the pack help to give balance, but it should be borne in mind that in that position they are most likely to get wet when, as frequently happens, the dogs walk into pools to cool off.

In the morning when the packs are first put on it is often necessary to make small adjustments so that the two sides balance perfectly. A few ounces transferred from one side to the other will usually make the difference between a well-balanced pack and one that keeps slipping. Several small items should therefore be left near the top for this purpose, or, if the packs are light, small stones may be added to one side. If the bottom of the pack is too broad or too tightly packed the dog may rub the forward edge of his hind leg, or the rear edge of his front leg, on a corner resulting in loss of hair and abrasion of the skin. The injury can be produced very quickly. It is therefore necessary to watch the dogs carefully when first starting, to see that their legs can move freely and that the packs are not too long. If a pack is too big for a dog, the corners may be turned inward and tied off with string, thereby decreasing the length of the lower edges.

On long trips, our eastern Arctic Eskimo dogs usually carried between 25 and 30 lb. depending on their size; the larger half-breed dogs used on Banks Island could carry rather more; and Douglas[3] mentions three dogs which carried more than 50 lb. each, but perhaps their travelling days were shorter.[4] For a short time, for instance, when carrying game to camp, dogs will carry very large loads. It appears that 8 hours of travel is a dog's limit, and when packing day after day, if they are made to do more than this, they will not only lag in the evening of that day, but also on the following day. Even when travel is limited to 8 hours the dogs tend to become slow and bored towards the end of a long trip, unless they can be given a day or two of rest now and again. This is particularly true if much of the walking is over sharp stones. Although the dogs are obviously uncomfortable and dislike this type of terrain, we have not noticed that it cuts or wears a dog's foot as is the case with ice. On Banks Island, a walk of one or two hours over sea ice in spring was enough to cause bleeding pads and necessitate the use of boots on some dogs. This is much less than the time it takes to cause the same damage when pulling a sledge with a normal load. Once back on the land, which was not very stony, the sores healed quickly, even though the dogs were not rested. At noon we usually stopped for about an hour, and on hot days, or when we were in no particular hurry, we would take the packs off the dogs. This, however, is not essential as they can rest quite comfortably with them on.

When travelling in caribou country we kept a lead attached to each dog's collar and tucked into the pack, where it could be seized quickly if we saw caribou. We would then lead them until out of sight and scent of the caribou. Otherwise, they were left to pick their own way. Actually we found that the dogs were unlikely to chase caribou very far, particularly when carrying heavy packs on a hot day. At the start of a trip they might run on a little way ahead, but they soon dropped back. On soft terrain they rarely lagged more than 100 yd. or so, but on sharp rocks, such as the disintegrated limestone of Prince of Wales Island, their speed might be reduced to about half that of humans, necessitating frequent waits to allow them to catch up. Unless the packs are completely waterproof, the dogs must be unloaded when they cross even quite shallow streams, and early in the season, when the streams are deep and cold, it is worth while carrying light-weight rubber waders which one can wear when crossing back and forth with the dogs' packs. The dogs can usually be induced to swim without much trouble.

To save weight, meat or fish carried for dog food must, of course, be dried. Even so, it is often necessary *en route* to add to the supply of food by hunting or fishing, and a small nylon fish-net or casting rod can usually be used to advantage on a long trip. The former is preferable for Arctic char and the latter for lake trout. Hunting by whites is strictly controlled in the Northwest Territories, and, when travelling without Eskimos, this may make the supply of dog food a problem and so limit the usefulness of pack dogs. Also, if only a few dogs are used, it is clearly wasteful to kill large game such as bear and caribou, as only a small amount of meat can be carried. However, if birds and mammals are being collected for scientific purposes, the carcasses make a useful food supplement. Parry's Ground Squirrel, which is abundant on parts of the mainland, is easy to secure and makes very acceptable dog feed. Some dogs, but not all, will allow themselves to get into quite poor condition before they will eat duck, or, in fact, most birds except geese and ptarmigan. When lemmings are abundant a dog will sometimes snatch up enough on the march to nourish him at least partially.

Dogs with long, broad, relatively flat backs from which the vertebrae do not protrude will bear a load more easily and keep a pack higher than will those which have narrow, sagging, concave backs. When possible, large, strong, long-legged, amiable dogs at or past the prime of life should be selected. At the same time, it is, of course, best to have dogs from a single team, or at least dogs which are used to running together, in order that fighting for social dominance may be minimized.

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FIELD WORK

DANISH SCIENTIFIC WORK IN GREENLAND, 1959

[Summarized from *Danish Arctic Research, 1955–59*, Arktisk Institut, København, 1960.]

West Greenland

Anthropology. The National Museum sponsored two projects during 1959. In continuation of the work carried out north of Søndre Strømfjord in 1956, K. Rønnow and two other architects studied the remains of eighteenth- and nineteenth-century buildings in the southern part of west Greenland. R. Petersen located forty-nine sites of early buildings in the central and southern part of the Sukkertoppen district, one of which, at Satormiut, belonged to the Dorset culture. A number of tape recordings of local folk-lore were made in this area.

B. Jensen continued his anthropological studies in the Ũmánaq area begun in 1956–57, by collecting information on unrecorded folk-lore and customs, with particular reference to the use and significance of sledge dogs in small hunting communities.

Geodesy. The following investigations were carried out by the Geodetisk Institut.

(*a*) Co-ordinates and levels. In collaboration with the International Glaciological Expedition, ground controls were made for a photogrammetric mapping, on the scale of 1:5,000, of the area around Kangerdlugssuaq, and the triangulation work of the expedition on the ice sheet was connected with the Institute's net along the west coast.

Ground controls were also made for photogrammetric mapping, on the scale of 1:2,000, of the coastline between Godthåb and Færingehavn and in the region of Rypeø. These are for use in a coming hydrographic survey.

(*b*) Air photography. Air photographs were taken in connexion with (*a*), except for the Godthåb–Færingehavn coastline where bad weather prevented photography on all but the most northern stretch.

The limits of the inland ice sheet between lats. 68° N. and 72° N. were photographed in connexion with the International Glaciological Expedition's programme. Vertical photographs were also taken of Inglefield Land and Daugaard Jensen Land as part of the general mapping scheme of Greenland.

(*c*) Seismology. The seismic stations at Ivigtut and Scoresbysund were in action throughout the season.

Geology. The Geological Survey of Greenland sponsored the following work in West Greenland.

(*a*) Ivigtut–Nunarssuit area. Seven groups, under the leadership of K. Ellitsgaard-Rasmussen and J. Bondam carried out the following programme: (1) survey of Nunarssuit intrusion and surroundings was completed; (2) survey of Sánerut was completed; (3) survey of low metamorphic rocks south of Kobberminebugt begun; (4) survey of granites in the Isorteq area was begun; (5) survey of Qanertoq, at mouth of Bredefjord, was begun; (6) granites around Qagssimiut were surveyed; (7) survey of granites in Sioralik was begun.

(*b*) Julianehåb–Narssarssuaq area: seven groups, under the leadership of J. Bondam, carried out the following programme: (1) survey of area between Igalikofjord and Skovfjord, north of lat. 61° N., was completed; (2) survey of area north of Sermilik was completed; (3) survey of Tugtotôq was completed; (4) survey of central part of Ilimaussaq intrusion was completed; (5) survey of sandstone area between

Narssaq and Qagssiarssuk was completed; (6) survey of granite area around Julianehåb, as far north as lat. 61° N., was completed; and (7) survey of vulcanite series between Narssaq and Qagssiarssuk was begun.

Geology of glacigene formations: A. Weidick carried out special investigations in ablation regions around United States scientific stations in the Thule area and on the ice sheet to the east. He also took part in an expedition to Hall Land in USS *Westwind*.

Geophysical investigations: "Sling-ram" investigations were carried out in southwest Greenland, and on a body of magnetite at Narssaq.

All parties were equipped with Geiger–Müller counters and made radio-activity measurements in connexion with their other work. Supplementary radio metric investigations were made in the area round Ivigtut, and in the sandstone area between Narssaq and Qagssiarssuk. Geochemical investigations into soils were made in the Ilimaussaq area, and the radio-active dykes in the sandstone area between Narssaq and Qagssiarssuk were examined. Diabase samples were collected in the Godthåb and Sukkertoppen districts, and a beryl-pegmatite dyke was mapped near Egedesminde. Samples of sand were collected in west coast fjords between Holsteinsborg and Fiskefjord.

Sociology. The team of six sociologists continued their work begun during the summer of 1958 in the Disko Bugt area. The main task was to interview 400 households, chosen at random, in order to collect representative views on various social problems. The team returned to Denmark in the autumn, after a year spent in Greenland.

Zoology. Ch. Vibe spent some time investigating the reindeer population problem in the areas around Søndre Strømfjord and Itivnera. Weather conditions prevented air-reconnaissance at the former place, where the population is estimated at between 6,000 and 10,000.

Biology. U. Røen carried out freshwater research in a number of lakes and ponds in Upernavik and Thule districts to extend earlier investigations of the physical and chemical conditions of various types of freshwater and the entomostrac fauna.

Fishery investigations. These were carried on from the laboratory at Godthåb and, for part of the year, from the cannery at Narssaq, also from M/S *Dana*. G. Høpner Petersen continued as scientific leader of the Universitetats arktiske station at Godhavn. The station has acquired a new ship *Porsild*, specially equipped for marine-biological work.

East Greenland

Archaeology. Helge Larsen joined a party of United States geologists on USS *Atka* and carried out archaeological surveys at a number of places between Angmagssalik and Kejser Franz Josephs Fjord. Palaeo-Eskimo remains were discovered at Umivik, Kap Tobin, Kap Hope and Kap Broer Ruys.

Geology. A party, led by S. E. Almgreen, worked at two areas during the season. On the north coast of Hold with Hope a survey was made, and fossil vertebrates and cephalopods were again collected in the Perm-Trias formations. Fossils were also collected in the Carbon formations of the Mesters Vig area.

Zoology. Ch. Vibe did not continue his usual animal work in east Greenland during the 1959 summer, spending it instead as consultant to the provincial council in Godthåb.

Fishery research. M/C *Adolf Jensen* operated in east Greenland waters from the early part of August until late September, but work was hampered by heavy ice, and was concentrated at Skjoldungen, Angmagssalik and Kungmiut.

Meteorology. Twenty-three weather stations and six radiosonde stations operated during the year according to international agreements. The auroral cameras at Kap Tobin and Station Nord were closed down during the summer. Work at the ionospheric station at Godhavn was temporarily interrupted by a fire in October but resumed a month later.

MARINE BIOLOGICAL STUDIES IN THE NORTH POLAR BASIN, 1959–60

[Summarized from outline unpublished report of Office of Naval Research and University of California Contract NONR 228 (19): *A study of marine biology of the North Polar Basin*, 1960.]

R. Lewis (University of South California) carried out field work on the drifting station "Bravo", or "T-3", from 6 November 1959 until 29 March 1960, and the programme was then continued by R. Lavenberg, of the same university. During the period, "T-3" moved from long. 154° W. to long. 144° W., between 71° and 72° N.

An animal community was only developed on the underside of the ice between 14 and 30 March, and it was then sampled. Information was gained about the reproductive cycles and commensals of *Gammarus wilkitzii* and *Gammaracanthus loricatus*.

About forty vertical plankton hauls were made, using a ½ m. net, while on 3 and 4 March the drift was fast enough to allow six horizontal tows. Collections will be analysed statistically and correlations attempted with depth of water, depth of haul, month of year, distance from shore, amount of sunlight and other factors. The dilution of the sea by meltwater affected plankton composition, and information about the salinity tolerance of various species, should be obtained. Some information about reproductive potential and food of plankton species has been collected, and the ostracod *Conchoecia maxima* has been selected for neurosecretion studies. A team of taxonomic specialists has been recruited to work on the collections.

The bottom fauna was sampled using an 'orange peel bucket' or dredge, but only 2480 m. of cable was available, so that work was impossible in the deepest water. The benthic isopods and tanaids have been identified by R. J. Menzies (University of Southern California).

In addition to these main programmes, a limited number of fish was collected by Lavenberg, and water samples were analysed chemically by J. Muguruma (Hokkaido University). Water samples and calcareous material were collected for palaeotemperature studies by H. Lowenstein (California Institute of Technology).

Several other areas were examined briefly. Cores and water samples were taken at Teshekpuk Lake, and in the marine pond "Nuwul" near Point Barrow, and from Eluitkak Pass into Elson Lagoon. G. Anderson (University of Southern California) is studying the foraminifers, and in particular is comparing those of shallow oceanic waters with those of the lagoon and the marine pond in relation to trace elements. H. Matsudo has described a new species of the protozoan *Heliochona* commensal on *Gammarus setosus* from "Nuwul" pond.

THE NORTHERN SEA ROUTE, 1960

[From *Vodnyy Transport*, 31 May, 2 June, 9 August, 29 September, 20 October, 27 October, 5 November, and Moscow Radio, 25 July, 19 August and 4 October 1960.]

The 1960 season was expected to continue longer than usual because the icebreaker fleet received two important additions: the atomic powered *Lenin* and the Diesel-electric *Moskva*. This expectation was justified (though less fully than had been hoped), in spite of difficult ice in the western sector, and especially in Proliv

Vil'kitskogo. *Lenin* left Murmansk on 29 May for a preliminary cruise in the northern Barents and Kara Seas to test her Arctic icebreaking capacity. She started escort work in mid-July. The first convoy of ships to the Yenisey arrived at Igarka on 15 July, between 1 and 2 weeks earlier than usual. Experimental sprinkling o coal dust on the ice of the estuary helped to break it up earlier. Proliv Vil'kitskog was first forced by a convoy escorted by the *Moskva* on 17 July, also about 2 weeks earlier than usual.

The most serious problem, caused by the failure of the ice to clear from Proliv Vil'kitskogo, was the passage of forty river vessels bound from the west to the Lena, Indigirka and Kolyma basins. This took place in the second half of September, and required the assistance of six icebreakers—*Lenin*, *Moskva*, *Krasin*, *Yermak*, *Kapitan Belousov* and *Kapitan Melekhov*. All the ships were brought safely to open water in the Laptev Sea.

In the eastern sector, however, the ice was more favourable. The first convoy reached Pevek from the east on 21 July. For most of the season no icebreaker assistance was needed on the stretch between Bering Strait and Tiksi, and this fact permitted ten ships to make the return voyage twice (in addition to others which made it once).

The season ended later than usual, again probably a result of the extra icebreaking potential. *Moskva* returned to Murmansk from Ostrov Diksona on 19 October, and *Lenin* on 25 October.

During the season seventy ships (thirty-two of them non-Soviet) called at Igarka for timber, of which 12 per cent more was exported than in 1959, although the number of ships was five fewer. Ten icebreakers are mentioned as functioning on the Northern Sea Route—the six mentioned above, together with three *Stalin*-class, *Iosif Stalin*, *Admiral Lazarev* and *Admiral Makarov*, and the remaining *Kapitan*-class, *Kapitan Voronin*. Twenty hydrographic ships carried out survey and ice patrol work. About 100 ships traversed Proliv Vil'kitskogo (including the river ships). Nearly 100 more river ships traversed the Kara Sea to the Ob' and Yenisey in addition to the forty which went on to the rivers beyond. The total number o freighters active on the Northern Sea Route is not given, but the published accounts contain references to a further forty or so, in addition to the seventy already mentioned as going to Igarka.

SCANDINAVIAN ARCHAEOLOGICAL AND QUATERNARY GEOLOGY EXPEDITION TO SPITSBERGEN, 1960

[Summarised from an unpublished paper by H. Christianssen. An account of previous work i this area appeared in the *Polar Record*, Vol. 8, No. 55, 1957, p. 348–49.]

During the summer of 1960, a party under the leadership of H. Christiansson Uppsala Universitet, worked at various sites between Isfjorden and Bellsund i Vestspitsbergen. The programme—archaeological, geological and ornithological—was in continuation and extension of those carried out in 1955 and 1958.

The main centre was at Russekeila, the site of a large Russian trapping station where a midden and burial ground were excavated. Two shafts were dug from th top of the midden down to the shore. The refuse layer proved to be 1–1·5 m. thick and contained large numbers of wooden objects, leather and textiles, also a larg crescent-shaped dish, some ornamental birch-bark boxes and some games pieces The base of the midden extended below the highest storm line on the shore; as th midden dates from the latter part of the eighteenth century there can have bee little, if any, land elevation here during the last 200 years. Twenty skeletons wer found wrapped in simple shrouds and with enamelled bronze crucifixes round thei necks in the burial ground. Other sites investigated were at Kapp Starostin and Trygghamna (on the north side of Isfjorden).

Some 130 samples were collected for pollen analyses, also samples of whalebone for ^{14}C dating. Botanical specimens were collected, and about 100 birds were ringed during the season.

ARCTIC TERRAIN RESEARCH OF THE TERRESTRIAL SCIENCES LABORATORY, UNITED STATES AIR FORCE CAMBRIDGE RESEARCH CENTER, 1960

[Summarized from reports of the United States Air Force Cambridge Research Center, Massachusetts, U.S.A. An account of the 1959 activities appeared in the *Polar Record*, Vol. 10, No. 65, 1960, p. 144–45.]

Ice-free land. During the summer of 1960 field parties worked at three locations in Greenland and two in Norway.

(*a*) North-east Greenland. A party, with S. M. Needham as project leader and accompanied by Eigil Knuth, Danish government archaeologist, worked between 5 May and 2 August at two sites in north-east Greenland.

Centrum Lake, in lat. 88° 08′ N., long. 22° 31′ W., was the first site, and the party was transported there partly by C-130 ski-equipped aircraft (in four landings on the frozen lake) and partly by United States Operation "Lead Dog" sledge team. The objects of the party were to prepare a runway on a fine soil terrace for test landings by C-130 wheeled aircraft, and to carry out meteorological, geological, soil engineering, permafrost, and topographical work in the area. A runway 4,600 ft. long and 200 ft. wide was prepared using two types of drags for surface smoothing, followed by rolling for compaction. Tests showed that compaction increased the strength of the surface by 50 per cent. The runway was proved for use by C-124, C-130 and C-119 aircraft.

Two helicopters were used for reconnaissance work in Kronprins Christians Land and Peary Land and operated partly from Centrum Lake and partly from a "Lead Dog" camp in Walcott Land.

The object was to evaluate potential sites for use as emergency runways, and to carry out studies in military and engineering geology, glacial geology, geomorphology and permafrost. With the aid of the helicopters, eleven sites were examined in an area of some 18,000 sq. miles.

(*b*) East coast of Greenland. This party, led by D. W. Klick and including Ole Skaerbo of the Ministeriet for Grønland, were prevented from carrying out a reconnaissance programme in the Daneborg and Danmarkshavn areas by lack of light aircraft support. They therefore concentrated on a site at Storelv which had been selected from preliminary reconnaissance in 1959. Neither this site, nor four others which were examined, proved suitable.

(*c*) Finnmark area, north Norway. During September, two three-man parties of geologists conducted field geological reconnaissances in this area. One party, under J. H. Hartshorn, operated in the Tanahus–Vadso–Bodø triangle and the second, led by W. E. Davies, in the Alta–Karasjok–Bodø area. Travel was by means of light aircraft and jeep, and a number of promising sites were discovered for further detailed investigation.

Ellesmere Ice Shelf. Between April and September a party of twenty-three, led by H. Lister, continued and extended the work of the previous season in Ellesmere Island and Ward Hunt Island. The object was to determine the history and character of the shelf, its relationship to its environment, and to develop techniques to improve its capacity to support traffic throughout the year. Work was carried out in the disciplines of meteorology, glaciology, geophysics, survey, tidal observations anc ice engineering.

Peters Lake, Alaska. Throughout the summer months, micrometeorological records were kept continuously, and geological investigations made by B. Reed, in the areas adjacent to the lake. Preliminary work shows that the previous concepts of the regional geology are likely to be revised in the light of more detailed reports.

The base camp at Lake Peters was substantially altered and improved, and can now accommodate fifteen scientists. A number of these, under contract to government, were housed during the season.

Two limnologists, J. Hobbie and a field assistant, are to make use of it during the winter.

Engineering properties of snow and ice. Following field tests at Point Barrow in March, experiments were carried out under controlled conditions in the Climatic Laboratory at Elgin Air Force Base under W. D. Kingerly. The object of these was to investigate methods and techniques of processing, strengthening and using ice as a structural material under field conditions, together with the study of the resulting ice properties. Experiments on the insulating properties of various aqueous foams generated under low temperature conditions were also carried out. The foams were proved to give excellent insulating protection for an ice surface under a large variety of conditions, and to be capable of being satisfactorily generated under field conditions.

Arctic Ocean drifting station, T-3. See *Polar Record,* Vol. 10, No. 67, 1960, p. 385–86.

JACOBSEN–McGILL UNIVERSITY ARCTIC RESEARCH EXPEDITION TO AXEL HEIBERG ISLAND, NORTHWEST TERRITORIES, 1959–61: OPERATIONS IN 1960

[By F. Müller. A report on the activities during 1959 was published in the *Polar Record* Vol. 10, No. 64, 1960, p. 45–46.]

The Jacobsen–McGill University Arctic Research Expedition is a joint undertaking of the Department of Geography, McGill University, Chairman, Professor F. K. Hare and Dr G. Jacobsen, of Montreal.

The main aim of the expedition is to study the evolution of the mountainous and strongly glacierized and glaciated area of the central part of western Axel Heiberg Island, Northwest Territories. The following earth sciences were integrated to further this central aim: surveying, glaciology, geophysics, meteorology, geomorphology permafrost research and botany. It is planned to extend the expedition until 1962 after which the facilities established will become a permanent Arctic research station for McGill University.

The 1960 project was financed from various sources, with a major contribution from the National Research Council of Canada, funds from the Swiss Foundation for Alpine Research and the British Mount Everest Foundation, and contributions from industry and individuals. Support in the field was given by the following Canadian government agencies: the Photogrammetric Research Section of the National Research Council, the Polar Continental Shelf Project and the Geographical Branch of the Department of Mines and Technical Surveys, the Meteorological Branch of th Department of Transport, the Royal Canadian Air Force and the Geophysic Section of the Defence Research Board.

During the summer of 1959 a reconnaissance party of four was in the field fo 6 weeks to determine the area of study and the base camp site, and to initiate th long-term glaciology programme.

The 1960 party consisted of twenty-seven members, some of whom were in the field for only part of the season.

Scientists in charge of the various disciplines were as follows: F. Müller, glaciology, also leader of expedition; B. P. Redpath, seismology; A. Becker, gravity; P. Fricker, geology; B. Robitaille, geomorphology; D. G. Haumann, survey; J. M. Havens, meteorology; and R. E. Beschel, botany. Professor J. B. Bird (geomorphology); G. Jacobsen and A. Lachenbruch (permafrost research) and Sven Orvig (glacial meteorology) spent short periods on the island in advisory capacities.

Logistics. The main party left Montreal on 7 May 1960, in a DC-4 charter aircraft and arrrived at Eureka Weather Station on the 8th. The same day a Piper Super Cub carrying the expedition leader and a Beaver landed on Axel Heiberg Island at the site chosen for the base camp. During the next three weeks, 55 tons of equipment, including the panels for two pre-fabricated fibreglass houses, were flown from Eureka to Axel Heiberg Island by a Beaver aircraft of Bradley Air Services Ltd., Ottawa.

Base camp was established near a small lake less than two kilometres from the tongue of "White Glacier',[1] in lat. 79° 25′ N. and long. 90° 30′ W. For this, two pre-fabricated fibreglass houses with living and working facilities for up to twelve men were erected.

Transportation on the island was most satisfactorily performed by one, at times two, Piper Super Cubs which operated on skis until mid-July and thereafter on large balloon tyres. A total of more than 760 flying hours was needed, and some 430 landings were made, practically all of them on unprepared ground. The flying was supervised by W. W. Phipps and Ross Bradley.

Throughout the season two Eliason motor-toboggans were used, and Nansen sledges were most successfully operated even on rough glaciers.

Glaciology, including hydro-glaciology. Two hundred and fifty-two stakes were inserted, surveyed and periodically checked for measurement of accumulation, ablation and surface velocity.

The following glaciers were studied:

(1) "Hugh Thompson Glacier", including part of the "McGill Ice Cap". This is an example of a large outlet glacier whose tongue is near equilibrium. Three cross-profiles were staked out, the upper one being on the ice cap and 9 km. long (30 stakes).

(2) "White Glacier". The tongue of this medium-sized, alpine-type valley glacier is in slight recession. Most work was done on this glacier. One major longitudinal profile marked with 75 stakes, and five cross-profiles were taken.

(3) "Baby Glacier" is a small remnant glacier which lies at an elevation of between 800 and 1000 m., and therefore lacks an accumulation area. Three cross-profiles were staked out.

The zone of equilibrium in the area was found to be at an altitude of from 950 m. to 1050 m.

Pressure waves were studied in a longitudinal profile of 14 stakes below the second ice fall on "White Glacier".

The previous winter's snow cover was investigated in some 50 pits. A major pit of 8 m. in depth was dug at an elevation of 1300 m. on the valley-type glacier. The lowest accumulation layer in this pit represented the year 1911. A second shaft, 4·5 m. deep and reaching down to the accumulation of 1933, was excavated near the culmination of the ice cap; it is planned to deepen this pit in 1961.

As temperature is a significant factor in the calculation of glacier flow, thermistors and platinum elements were frozen into 10 m. drill holes in the accumulation area, the zone of equilibrium and on the tongue of "White Glacier".

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[1] Geographical names in inverted commas have been submitted for approval to the Board of Geographical Names for Canada.

A special study of rate and modus of ablation and of the related run-off was made; in addition to the classical current meters the much more accurate Thompson weir and the chromate dilution methods were also used.

Geophysics. The geophysical programme was closely related to the glaciological studies. The geophysicists frequently operated with the glaciologists, using the accumulation and ablation stakes and their elevation values for gravity and seismic stations. Ice thickness was determined by gravity measurements at 178 stations, and by seismic sounding at 24 points. Three velocity profiles were shot, using a 12-channel, high-resolution, reflexion seismograph. For the gravity work a Worden gravimeter was used, reading to 0·01 milligal. In addition 17 gravity stations were established around the shore-line of Axel Heiberg Island in order to study the isostatic readjustment of the area.

Glacial meteorology. Two stations were established. The "Upper Ice Station", near the culmination of the "McGill Ice Cap" and at 1700 m., was operated from 29 May until 28 August. The "Lower Ice Station", situated in the ablation zone of the "White Glacier" at 220 m. above sea level, was run from 16 May to 26 August. Professor Svenn Orvig spent the first ten days with the party to initiate the meteorology programme. Instrumentation for radiation and general glacial-meteorological observations in the first 8 m. of the air mass above the glacier surface was similar at both stations. The compact Mörikofer solarimeter and the self-recorders driven by watch springs were used very successfully.

For comparison, a third weather station was run on bare land near Base Camp (180 m. above sea level). The maximum temperature recorded at Base Camp was 18° C., at the "Lower Ice Station", 14° C., and at the "Upper Ice Station", 8° C.

Surveying. A programme of photogrammetric surveying of the expedition area was organized by the Photogrammetric Research Station of the National Research Council of Canada. Basic methodological research was carried out while the ground control network for the low level air photography was laid out. This network, consisting of points of I to IV order, covered the three typical glaciers of the expedition area. The altitude of this terrain ranges from sea level to about 1800 m. above sea level, the total area being about 800 sq. km. Some 23 signals, 31 cairns and 51 plates were set up as ground markers. The base-line for the triangulation was measured with a tellurometer by the survey team of the Polar Continental Shelf Project. In the last few days, the Swiss mountaineers J. Marmet and E. Leuthold assisted and made it possible to complete the ground survey on schedule. On 2 August a Lancaster of 408 Squadron, Royal Canadian Air Force, successfully flew twelve low-level air-photograph flight lines over the area at heights ranging between 1700 m. above sea level over the glacier tongues, and 6100 m. above sea level over the ice cap. The camera used was a Wild RC8. Four flight lines were re-flown at a different time of day on 15 August.

Geomorphology. Dr Robitaille, of the Geographical Branch, paid special attention to the morainic deposits at the glacier termini and to marine strand lines in his survey of the geomorphology. After about six weeks of quantitative fieldwork in the vicinity of the base camp a more qualitative study of the morpho-structural and morpho-climatic features covering the northern half of Axel Heiberg Island was made.

Marine shells were found in the western part of the island at 70 m. above sea level, on the eastern side at 130 m., and near Eureka at an elevation of 210 m.

Tent rings were discovered on the north-eastern side of the island and in the vicinity of Eureka, indicating that Eskimos had visited the area while hunting.

Geology. Geological work was mainly concerned with analysing the bed-rock structures in the areas of the glaciological and geophysical profiles and with the tectonic factors controlling the valley pattern. Stratigraphic work was done so that a detailed geological map of the expedition area can be compiled. A rich collection of fossils ranging from Upper Triassic to Upper Cretaceous times was gathered. The numerous dykes and sills which cut through all the sediments of the area, except the Upper Cretaceous layers, are included in the folding system, which is probably of early Tertiary age.

The gypsum structures, remarkably frequent and influential in the area, were the subject of a special study by Ernest Hoen.

Botany. The botanical studies were focused on lichenometry and pollen-analysis. Several of the sub-recent moraine stages of the expedition area have been dated tentatively. Some very rich peat profiles were discovered, the thickest having a depth of almost 3 m. at an elevation only a few metres above present sea level. The ^{14}C-dating of this material is expected to supply most significant facts to the glacial history of the area. Thirty-two samples for ^{14}C-dating, and some 450 samples for pollen analysis were collected. The vegetation is unexpectedly rich. The number of known tracheophyta species has been increased from 77 to about 135, the number of Bryophyta from about 20 to some 200 and the Lichens from 7 to about 250 species.

Permafrost research. The important decision regarding the location of the deep-drilling operation was made during a visit by Lachenbruch and Jacobsen. The site of the main hole will be on the gently sloping east side of the island, half-way between "McGill Ice Cap" and Schei-Peninsula.

Mountaineering. The highest mountain on the island, ±7,000 ft. and several other major peaks were climbed and explored.

Film. A film of the expedition at work, made by C. R. Crawley, will feature scientific methods and instrumentation.

Operations in 1961. The 1961 operations are planned to be on a similar scale. The "Upper Ice Station" will be run on a reduced programme, while more detailed work is envisaged for the "Lower Ice Station". Concentration on the study of the three main glaciers and adjacent areas will continue, using the contour line maps of scale 1:50,000, and larger, which will be available by next season.

ARGENTINE ANTARCTIC EXPEDITIONS, 1957–58, 1958–59 AND 1959–60

[Summarized from information provided by the Institute Antártico Argentino. Accounts of previous expeditions were published in the *Polar Record*, Vol. 9, No. 60, 1958, p. 242–43 and earlier issues.]

Season 1957–58

The following stations were in operation: "Orcadas", "Teniente Cámara", "Melchior", "Almirante Brown", "Esperanza", "General San Martín", "General Belgrano" and "Decepción".

During the winter of 1957 a comprehensive glaciological programme, as part of the Argentine contribution to the IGY, was followed at "General Belgrano", "General San Martín" and "Esperanza", and snow research at the remaining stations.

Auroral and biological studies were also made and, at "General San Martín", R. Mauri and A. Corte carried out an oceanographical and biological programme.

On 23 December 1957, a fire broke out at "General Belgrano", destroying equipment and records.

The relief expedition was commanded by Capitán de Navío Alberto Patrón Laplacette, and consisted of the icebreaker *General San Martín*, the transport *Bahía Aguirre* and the survey ship *Chiriguano*, also two helicopters.

Five parties of scientists were sent to the South Shetland Islands by the Instituto Antártico Argentino. There they carried out studies in geology and petrology

(O. Schauer and N. Fourcade); chemistry (A. Moscoso Boedo); meteorology (J. Scholten); biology (R. Mauri and A. Corte); aurora (O. Schneider) and geomagnetism (R. Slaucitajs). During the relief of the stations, oceanographical, hydrographical, meteorological and cartographical work was carried out. Gravimetric studies were also carried out by the Instituto Geográfico Militar.

During the summer an all-sky camera was installed at "General Belgrano".

Season 1958–59

he following stations were in operation: as in 1957–58.

Glaciological investigations were continued from the previous season. Scientists from the Instituto Antártico Argentino and the United States Fish and Wildlife Service collaborated in a study of the distribution of the South Polar Skua (*Catharacta skua*).

The stations "General San Martín" and "Esperanza" were destroyed by fire during 1958.

The relief expedition, commanded by Capitán de Navío A. A. R. Schulze, consiste of the icebreaker *General San Martín*, the transport *Bahía Aguirre*, the survey shi *Chiriguano* and helicopters—which were used in relief of the station "General Sa Martín". The Instituto Antártico Argentino sent five groups of scientists an technicians who worked in north-east Graham Land, the South Shetland Islands an in the Weddell and Bellingshausen Seas. The disciplines studied were: biology (A Corte); human physiology (G. Gesino); geology (O. Schauer and N. Fourcade) meteorology (J. Gómez) and geography (H. O. Pallardó). During the relief of the stations observations were made as in 1957.

The United States station "Ellsworth" was taken over by Argentina on 15 July and is to be administered by the Instituto Antártico Argentino.

Season 1959–60

The following stations were in operation: as in 1958–59 with the addition o "Ellsworth". During the summer the stations "Almirante Brown" and "Teniente Cámara", both staffed by naval personnel, were evacuated and converted to refuge huts for 1960. The station "General San Martín" was again destroyed by fire, i February 1959, and could not be rebuilt as the *General San Martín* was unable to reac the site owing to ice conditions in Marguerite Bay.

The relief expedition was commanded by Capitán de Navío J. A. Boffi, and con sisted of the icebreaker *General San Martín*, the transport *Bahía Aguirre*, the surve ship *Chiriguano* and supporting helicopters.

The Instituto Antártico Argentino sent four parties of scientists and technician who worked in the Weddell Sea, the South Shetland Islands, Marguerite Bay an the Bellingshausen Sea. Disciplines studied were: biology (R. Novatti); geolog (O. Schauer); glaciology (R. Dalinger); meteorology and geochemistry (J. Gómez) and cosmic rays (O. A. Cicchini) using special equipment installed in *General Sa Martín*. During the relief voyages observations were made as in 1957.

Owing to ice conditions it was not possible to relieve the stations "Ellsworth" and "General Belgrano", while personnel only were relieved at "General Sa Martín".

ASCENT OF MOUNT PAGET, SOUTH GEORGIA, 1960

[Summarized from information supplied by HM Navy.]

A party of fifteen Royal Marines and one naval officer under the leadership of Capt. V. N. Stevenson, R.N., climbed Mount Paget, the highest, and unclimbed, peak in South Georgia, between 10 and 15 December 1960.

They were landed by helicopter from HMS *Protector* near Cape Darnley and some 10 miles south-west of Mount Paget. After three days of difficult travel over glacier-covered and heavily crevassed terrain, Stevenson, Lt. Cdr. M. K. Burley, R.N. and Cpl. B. Todd reached the summit of the west peak (9565 ft.).

The party were re-embarked by helicopter on the 15th.

FALKLAND ISLANDS DEPENDENCIES SURVEY, 1959–60

[From information supplied by Falkland Islands Dependencies Survey.]

The following stations were in operation during the winter of 1959: Port Lockroy (Base A); Deception Island (Base B); Hope Bay (Base D); Argentine Islands (Base F); Admiralty Bay (Base G); Signy Island (Base H); Horseshoe Island (Base Y); and Halley Bay (Base Z), and the meteorological station at Grytviken.

Relief voyages, 1959–60

RRS *John Biscoe*, *Shackleton* and charter ship MV *Kista Dan* were used to relieve and re-supply stations during the season, though operations were hampered by the presence of severe ice conditions in Graham Land waters.

Between 26 November and 23 December 1959, *John Biscoe* relieved the northern stations, Signy Island, Admiralty Bay, Deception Island, Hope Bay and Port Lockroy, without difficulty. After returning to Stanley, she called at South Georgia on her way to the Weddell Sea and, after penetrating several hundred miles of heavy sea ice, succeeded in relieving Halley Bay on 20 January 1960. After visiting a number of stations during a third southern voyage she left Stanley on 23 April for the United Kingdom.

Shackleton spent two weeks making gravity and magnetism observations along the Scotia Arc, and visited northern stations between November 1959 and February 1960, before leaving for Cape Town on charter to the South African Government.

Kista Dan carried two aircraft, a Beaver and an Otter. Both were assembled at Deception Island and the Beaver, fitted with floats, was used for reconnaissance purposes during the southern voyage. The Argentine Islands station was relieved in mid-February, but ice made it impossible to enter Marguerite Bay, even with the assistance of USS *Glacier*, which aided *Kista Dan* when she was beset for thirteen days in the neighbourhood of Cape Alexandra. Plans to establish a new station on Adelaide Island, and to re-open Stonington Island station (Base E) as an air-base had therefore to be abandoned, and the Horseshoe Island station was then relieved by air. The six-man party intended for the new Adelaide Island station (Base T) were left to winter at the old hut on Winter Island, Argentine Islands, and the six-man party for Stonington Island wintered at Deception Island. On 16 September the Otter and Beaver aircraft flew from Deception Island to the Argentine Islands to transport the party to Adelaide Island. The Beaver, while taxiing in on arrival, broke through the ice and became a complete casualty. The Otter, which was to be kept in reserve for summer operations then returned to Deception Island with the air unit. The Adelaide Island party remained at the Argentine Islands.

The total number of men wintering in 1960 was ninety.

Field work, 1959–60

Physical sciences. The Argentine Islands and Halley Bay stations have maintained a full programme of geophysical, meteorological, auroral and tidal observations. The upper-air programme at Halley Bay was limited to one ascent a day owing to a shortage of radio-sondes, but the average heights were the greatest ever achieved in the Antarctic, being consistently over 20 km. except for a period in May.

A phosphorus pentoxide electrolytic hygrometer was successfully tested at Halley Bay, and proved practicable for continuous measurements of humidity at temperatures below –20° C.

Ionospheric soundings and radio research were carried out at Halley Bay and Port Lockroy, but were temporarily discontinued at the former in 1959 owing to mechanical breakdowns.

A magnetometer survey of Tabarin Peninsula, Duse Bay and the northern part of Prince Gustav Channel was completed by parties from Hope Bay, and Dr D. H. Griffiths (Birmingham University) used a ship-borne proton resonance magnetometer to carry out a preliminary magnetic survey of the Scotia Arc and parts of the South Shetland Islands. Gravity measurements were undertaken in the South Shetland Islands and on the north-west coast of Graham Land.

Dr G. de Q. Robin (Scott Polar Research Institute, Cambridge) investigated the damping effect of sea ice on wave motion in the Weddell Sea, by means of a wave-recorder fitted to the *John Biscoe*.

Meteorological and auroral observations have been maintained at eight stations.

Topographical survey. Surveyors, operating from Hope Bay during the southern winter of 1959, extended the triangulation of Trinity Peninsula to provide ground control for mapping from the 1955–57 vertical air photography. During the 1959–60 summer, priority was given to the tellurometer link-up between the triangulations of the South Shetland Islands and Trinity Peninsula and, for this purpose, parties were transported by ship and helicopter to various localities in Bransfield Strait. Work during the 1960 winter has been curtailed by the failure to re-open the station at Stonington Island and establish the new station on Adelaide Island as planned.

Geology. The detailed geological survey of the Argentine Islands, King George Island and parts of the north coast of South Georgia has now been completed, and reconnaissance work has been carried out on the north-east part of Livingston Island. Parts of the James Ross Island group and exposures on the west coast of Gustav Channel have been mapped in detail with particular reference to the stratigraphy and palaeontology. The Neny Fjord area of Marguerite Bay was mapped with special reference to the stratigraphy of the Basement Complex.

Glaciology. Glaciologists at Hope Bay undertook routine observations on accumulation, ablation, temperature profiles and firn stratigraphy, and on the movement of several glaciers.

At Admiralty Bay, King George Island, investigations were continued on cirque and valley glaciers.

Accumulation, ablation and movement of an ice shelf were studied at Halley Bay, and the rate of movement was found to be 413 yards per year. The rate of formation of sea ice was investigated in relation to energy balance.

Routine sea ice observations were maintained at all stations.

Biology. At Signy Island, South Orkney Islands, research continued into the population dynamics, and migrating and breeding habits of three species of seals. The study of soil fauna, and the collection of freshwater and marine littoral material have been initiated. The ornithological programme has included work on migration, longevity, and the breeding behaviour of penguins and petrels.

Detailed work on the life cycle of the Emperor Penguin continues at Halley Bay, a precisely timed series of embryos having been obtained in 1959.

Human physiological studies were carried out at four stations; these included an investigation of micro-climates.

HMS Protector, 1959–60

HMS *Protector*, Captain D. N. Forbes, R.N., made five southern voyages from Stanley during the season. During the first of these, between 1 and 23 December 1959, she visited South Georgia, her helicopters photographing Willis Islands from the air, and landed a Royal Marine detachment for cold weather training.

The main objects of her next two voyages were the transport, and helicopter support, of a tellurometer party in the Bransfield Strait area. During her fourth voyage she carried the Governor of the Falkland Islands on a visit of inspection to the FIDS stations at Port Lockroy, the Argentine Islands, Deception Island, Hope Bay and Signy Island, and the whaling stations at South Georgia. Air photography by helicopter was continued over South Georgia, and landings made on the South Sandwich Islands.

On the final voyage, the Royal Marine detachment spent four days on Livingston Island, and personnel, stores and mail were airlifted to the Argentine Islands, Port Lockroy, Hope Bay and Admiralty Bay. This voyage ended at Stanley on 22 March 1960.

APPENDIX. *Wintering parties at FIDS stations*, 1960

Port Lockroy, Wiencke Island, Palmer Archipelago (Base A)

J. C. Cunningham, Officer-in-charge and general assistant/mountaineer
K. Austen, Scientific assistant
P. H. Leek, Scientific assistant
E. Watson, Diesel electric mechanic
B. C. Williamson, Wireless operator mechanic

Deception Island, South Shetland Islands (Base B)

I. T. Jackson, Officer-in-charge and meteorologist
G. F. Fitton, Wireless operator mechanic
R. P. Matthews, Senior meteorologist
M. H. Tween, Diesel electric mechanic
B. P. Westlake, Meteorologist

Hope Bay, Trinity Peninsula (Base D)

N. W. M. Orr, Officer-in-charge and medical officer
N. Aitkenhead, Geologist
A. Allen, Geophysicist
K. Allen, General assistant/mountaineer
D. S. Baron, Meteorologist
C. G. Brading, Assistant surveyor
J. Cheek, Wireless operator mechanic
I. L. Fothergill, Meteorologist
I. F. G. Hampton, Physiologist
R. A. E. Harbour, Assistant surveyor
R. Miller, General assistant/mountaineer
W. Mitchell, Diesel electric mechanic
P. H. H. Nelson, Geologist
J. M. Smith, Meteorologist
R. Tindal, General assistant/mountaineer
W. O. Tracey, Meteorologist
J. Winham, Meteorologist

Stonington Island, Fallières Coast (*Base E*)

D. P. English, Officer-in-charge and pilot
P. C. Bates, Airframe fitter
R. A. Lord, Pilot
C. J. Pearce, Meteorologist
T. Sumner, Aircraft fitter
F. A. Whyte, Wireless operator mechanic

Argentine Islands, Graham Coast (*Base F*)

C. A. Murray, Officer-in-charge and surveyor
H. E. Agger, Scientific officer
A. W. Gallagher, Meteorologist
R. S. M. Harkness, Diesel electric mechanic
P. J. A. Haynes, Cook
D. R. Jehan, Meteorologist
A. Piggott, Wireless operator mechanic
I. Preece, Physicist
J. A. Quinn, Wireless operator mechanic
F. P. Smith, Meteorologist
B. R. Sparke, Medical officer
M. R. Sumner, Meteorologist
R. H. Thomas, Meteorologist
J. B. Wigglesworth, Forecaster

Admiralty Bay, King George Island, South Shetland Islands (*Base G*)

M. D. Kershaw, Officer-in-charge and diesel electric mechanic
C. M. Barton, Geologist
N. Y. Downham, Meteorologist
J. Elliott, Wireless operator mechanic
J. E. Ferrar, Meteorologist
N. V. Jones, Meteorologist
J. M. Wilson, Diesel electric mechanic
R. G. Wright, Meteorologist

Signy Island, South Orkney Islands (*Base H*)

R. B. Harrison, Officer-in-charge and meteorologist
D. A. Clarke, Diesel electric mechanic
R. Filer, Meteorologist
P. W. Mander, Meteorologist
R. Pinder, Wireless operator mechanic
P. O. White, Meteorologist

Adelaide Island (*Base T*) (Wintering at Base F)

E. C. J. Clapp, Officer-in-charge and wireless operator mechanic
A. Crouch, Meteorologist
A. G. Fraser, Geologist
H. C. G. McCallum, General assistant/mountaineer
F. Preston, Assistant surveyor
J. C. A. Stokes, Assistant surveyor

Horseshoe Island, Fallières Coast (*Base Y*)

P. D. Forster, Officer-in-charge and assistant surveyor
A. G. Davies, Medical officer
P. H. Grimley, Geologist
C. Le Feuvre, Wireless operator mechanic

Halley Bay, Caird Coast, Coats Land (*Base Z*)

N. A. Hedderley, Officer-in-charge and meteorologist
D. A. Ardus, Glaciologist
J. R. Blackie, Physicist (Aurora)
M. F. Brittain, Radar mechanic
C. H. Dean, Physicist

C. R. Forrest, Medical officer
C. N. Horton, Scientific officer
C. Johnson, Wireless operator mechanic
A. G. Lewis, Scientific assistant
J. E. MacDonald, Scientific assistant (ionospheric)
A. Millar, Meteorologist
G. H. Moore, Cook
G. H. Talmage, Diesel electric mechanic
M. H. Taplin, Meteorologist
M. H. Thurston, Biologist
W. H. Townsend, Meteorologist

Grytviken, South Georgia (*Base M*)

D. Borland, Forecaster
D. O'Regan, Meteorological assistant
M. T. Reade, Meteorological assistant

SOUTH AFRICAN NATIONAL ANTARCTIC EXPEDITION, 1959–60

[From information obtained from South Africa House, London, and a private communication.]

The first South African National Antarctic Expedition left Cape Town on 3 December 1959 in the charter vessel *Polarbjørn*. The party consisted of H. la Grange (Leader), D. J. Bonnema, G. F. Strauss, W. T. de Swardt and M. H. van Wyk, meteorologists; V. von Brunn, geologist and geophysicist; A. le R. van der Merwe, medical officer; two radio operators and a diesel mechanic. Disciplines to be studied were geology, geophysics, meteorology and physiology.

Polarbjørn arrived off Bouvetøya on 10 December but did not attempt to land owing to stormy weather. It appeared that there had been a large landslide on the west coast of the island resulting in the formation of a plateau about ½ mile long by 300 yd. wide just south of Kapp Circoncision. While approaching Dronning Maud Land, *Polarbjørn* was intermittently beset for three weeks until the arrival of the Argentine icebreaker *General San Martín* on her way to relieve "General Belgrano" station. *Polarbjørn* followed in her tracks for about 150 miles. "Norway" station was reached on 8 January 1960, the South Africans disembarked and the Norwegian party were relieved. During the return voyage *Polarbjørn* spent some days at Maudheim.

NOTES

UNIVERSITY OF ALBERTA: BOREAL INSTITUTE

[From information supplied by the University of Alberta.]

The Boreal Institute of the University of Alberta was established on 1 April 1960, and has as its object the dissemination of knowledge about Arctic and sub-Arctic regions. This is to be implemented by the setting up of an information centre, the provision of training and instruction for students, and the undertaking, co-ordination and administration of research in the area.

METHOD OF HASTENING THE MELTING OF FLOATING ICE

[From a paper by I. S. Peschanskiy in *Priroda* (*Nature*), 1960, No. 7, p. 49–54.

Work has been done in the U.S.S.R. on hastening the melting of floating ice by means of sprinkling the surface with a dark substance.[1]

It has been established that it is not worth reducing the albedo by more than 20 per cent. Excessive darkening can lead to a retarding of the melting process because the dark layer may insulate the ice below. It has been found that best results are obtained by sprinkling black sand, or sand mixed with coa dust, at a density of 300–400 g. per sq.m., 1½–2 months before the natura melting period. Sprinkling is carried out from a tractor-drawn sledge, if a settlement is near at hand, otherwise from an aircraft. In the latter case a given area must be overflown 15–18 times in order to achieve the necessary density. A strip 1 km. long may be treated in three flying hours.

Some of the most successful results have been obtained at the port of Pevek (lat. 70° N., long. 171° E.), which lies in a bay 50 km. from the open sea. The bay often remains frozen until July and even August, while the sea breaks up considerably earlier. In 1952 dirt was laid along the sea ice for 60 km. between Pevek and the open sea, the operation lasting from 24 April to 25 May. The resulting channel permitted ships to enter the port without icebreaker assistance on 23 June, the earliest recorded date.

SOVIET ANTARCTIC MAPS

The Ministry of the Merchant Fleet [Ministerstvo Morskogo Flota] published in 1959 a series of land maps of the Antarctic, based on air photography and ground control obtained by the Soviet Antarctic expeditions, mainly durin the field season of the second party (1956–57). A set of these maps is now held at the Scott Polar Research Institute. The work of compilation was done by the air survey branch of the Ministry's Institute "Soyuzmorproyekt" under the supervision of the Arctic and Antarctic Research Institute [Arkticheski i Antarkticheskiy Nauchno-Issledovatel'skiy Institut]. There are five sheets at the scale of 1:1,000,000 covering coastal areas between long. 72° and 120° E. 23 sheets at 1:100,000 covering certain areas within these, namely Bunge Hills (five sheets), Wilkes station (two sheets), Mirnyy and the coast to th west (eight sheets), Gaussberg area (four sheets), and Davis station (four sheets); and eight sheets at 1:50,000 covering the Bunger Hills. The sheet lines and the system of numbering sheets conform to the plan for the map of the world at 1:1,000,000 [Carte du monde au millionième].

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[1] See *Polar Record*, Vol. 9, No. 59, 1958, p. 153–54.

All place-names are, of course, given in cyrillic letters with the generic terms in Russian. While many new Russian names appear (they are to be found in the Soviet gazetteer),[1] much care has clearly been taken to use western names wherever they exist. The compilers have even gone so far as to find and use western names not yet officially approved by the appropriate place-names authority, as Kholmy Grirsona [Grierson Hills], near Wilkes station. This evident desire to respect earlier achievements, and the careful way it is put into effect, is very laudable. Sometimes the generic as well as the specific part of western names is transliterated into cyrillic, with a new Russian generic added, as Kholmy Banger-Khils [= Bunger Hills Hills]—a pleonasm very common in the history of place-names.

The main point of interest about the maps is undoubtedly the way in which the numerous problems presented by ice phenomena have been resolved. Five colours are used: blue for water features, brown for ice-free land, pink for ice shelf, pale green for the inland ice-sheet, and grey-green for ice streams. The last-named distinction is an innovation, and a useful one. It has the disadvantage, however, that the edge of the ice stream has to be shown on the map as a clearly defined line where the colour changes, whereas on the ground the edge of an ice stream is often an area rather than a line, and can be very difficult to determine at all. Conventional signs are explained in the key on each sheet, and more fully, with English translations, in a key issued separately (headed "Legends for maps of Antarctic continent"). There are three symbols for coastal ice cliffs. One corresponds to our ice wall (where the ice is aground); this one is used as well to indicate non-coastal ice cliffs, for instance those bordering declivities in ice shelves. It is also used coastally in another colour (blue instead of green), but the meaning of this is not given in the key. The other two symbols correspond to our ice front (where the ice is afloat); one marks the seaward edge of an ice shelf, and the other the seaward edge of a glacier tongue or ice stream. This subdivision of ice front permits the areas with the greatest likelihood of change to be distinguished. Both ice front symbols are qualified by dates. Crevassing and drainage patterns in the ice are also indicated in considerable detail. Certain icebergs are marked, and at the larger scales spot heights are even shown on many of them. Presumably these icebergs are aground (although this is not stated), but even so the usefulness of showing them on maps seems questionable. In general, the handling of the ice problems testifies to careful thought. Not all the solutions found may be ideal—this is, after all, a pioneer work in certain respects—but many are good, and the problem as a whole has been faced in a way which denotes a full understanding of the position.

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[1] M. M. Somov, ed., *Perechen' geograficheskikh nazvaniy vostochnoy Antarktidy* [*List of geographical names of eastern Antarctica*], Leningrad, 1959. See *Polar Record*, Vol. 10, No. 65, p. 164–65.

ABSOLUTE AGE OF ANTARCTIC ROCKS

[From papers by M. G. Ravich and A. Ya. Krylov in *Informatsionnyy Byulleten' Sovetskoy Antarkticheskoy Ekspeditsii* [*Information Bulletin of the Soviet Antarctic Expedition*], No. 19, 1960, p. 8–9, and No. 20, 1960, p. 15–17; and by M. G. Ravich, A. Ya. Krylov, I. Ye. Starik and Yu. I. Silin in *Doklady Akademii Nauk SSSR* [*Reports of the Academy of Sciences of the U.S.S.R.*], Tom 126, No. 1, 1959, p. 144–46. Co-ordinates added from other sources.]

The following determinations have been made by the argon method:

Rock	Where collected (east longitude given to nearest degree. All sites are near the coast)	Age (millions of years)
Biotite pegmatite	"Gora Lodochnikova" (northern spurs of Conradfjella) (10°)	400
Cataclased fine-grain granite with biotite and garnet		450
Cataclased alaskite-like granite (from vein)		420
Porphyroblastic hornblende granite	Northern spurs of Conradfjella (10°)	460
Cataclased migmatized garnet-biotite gneiss	Schirmachervatna (14°)	390
Pegmatoid plagiogranite with muscovite		400
Feldspathized and biotized pyroxene plagiogneiss	Forposten (20°)	475
Cataclased pegmatoid plagiogranite		460
Hypersthene granosyenite (charnockite)	Mawson (63°)	535
Biotized pyroxene plagiogneiss		555
Garnet-biotite schist with spinel		490
Basalt	Gaussberg (89°)	20
Leucocratic granite	Long Peninsula (78°)	1070
Pegmatite		1270
Veined amphibolite granite	Mirnyy, "Ostrova Stroiteley" (93°)	450
Pyroxene plagioclase schist (xenolith in charnockite)	Mirnyy, "Sopka Morennaya" (93°)	440
		430
Charnockite	Haswell Island (93°)	455
Pegmatoid granite	David Island (99°)	525
Porphyroblastic granite		430
Biotite schist	Mount Strathcona (99°)	925
Leucogranite from migmatite	"Kholmy Obrucheva" (100°)	1070
Aplite-like granite		515
Biotite-pyroxene gneiss	Bunger Hills (101°)	590
Biotite-pyroxene gneiss		940
Boulder of rapakivi		760
Charnockite		700
Migmatite		730
Migmatite		730
Migmatite		700
Pegmatite		705
Charnockite	"Grierson Hills" (111°)	780
Leucogranite		1020
Charnockite	Henry Bay (121°)	660
Charnockite	Henry Bay (121°)	720
Pegmatoid granite	"Skala Al'bova" (127°)	1020

Rock	Where collected (east longitude given to nearest degree. All sites are near the coast)	Age (millions of years)
Porphyroblastic granite	Ainsworth Bay (147°)	450
Xenolith from porphyroblastic granite		450
Xenolith from porphyroblastic granite		450
Biotite gneiss		485
Biotite gneiss		445
Gabbro-dolerite	"Gora Obrucheva" (154°)	170
Quartz-albite vein	"Gory Berga" (156°)	450
Schistose phyllite		500
Veined muscovite granite	Wilson Hills (158°)	460
Biotite gneiss		425
Biotite gneiss		445
Biotite granite	Rennick Bay (162°)	315
Biotite-hornblende granite	"Ostrova Sputniki" (163°)	305
Schistose phyllite	"Lednik Zykova" (165°)	410
Fine-grained mica schist		400

Note. Place-names shown in inverted commas have not yet been approved by the appropriate Norwegian and Australian authorities.

FIFTIETH ANNIVERSARY OF THE SAILING OF *TERRA NOVA* FROM NEW ZEALAND, 26 NOVEMBER 1960

On Saturday, 26 November 1960, the Scott Polar Research Institute celebrated the fiftieth anniversary of the sailing from New Zealand of the *Terra Nova* with the British National Antarctic Expedition, 1910–13. A sherry party was held for the Friends of the Institute in the museum, where photographs, equipment, note books, private journals, and paintings by Dr E. A. Wilson had been arranged in a special commemorative exhibition. Three members of the expedition were there, Professor Debenham, Sir Raymond Priestley and Sir George Simpson; Miss Bowers, sister of Lieutenant Bowers, made a special journey from Scotland to attend, and Sir James Wordie of Shackleton's *Endurance* expedition and Mrs Ferrar, widow of H. T. Ferrar, geologist Scott's *Discovery* expedition, were both present. Tape-recorded messages from Australia were sent by C. H. Hare of the *Discovery* expedition and T. Griffith Taylor, and through the kindness of Mr A. Campbell-Drury of A.N.A.R.E., greetings were also sent on tape from R. W. Richards, A. Keith Jack and I. O. Gaze of Shackleton's 1914–17 expedition and Dr Frank Stillwell of the Australasian Antarctic Expedition, 1911–14.

Later in the evening H. G. Ponting's film *Ninety Degrees South* was shown before a very large audience; it was introduced by Professor Debenham, who talked about the film's making and about Ponting, and at the end of the evening Sir George Simpson spoke about the start of the South Pole journey.

SCAR BULLETIN

No. 8, *May* 1961

Conservation of Nature in Antarctica

At the fourth meeting of SCAR a report on the Conservation of Nature in Antarctica, prepared by the Working Group on Biology, was provisionally accepted subject to approval by National Committees. National Committees were given the opportunity of expressing their views on the document to the Executive Committee of SCAR by the end of 1960. Comments from nine National Committees have been received. Seven National Committees expressed general approval of the document although detailed alterations were suggested by two committees. The two remaining National Committees informed the Executive Committee of the general principles which they considered should form the basis of the Conservation of Nature in Antarctica. These principles did not differ in their major essentials from those set out at the fourth meeting of SCAR.

After considering the views of National Committees, and bearing in mind the need to avoid unnecessary delay in circulating a statement on the Conservation of Nature in Antarctica, the Executive Committee, in consultation with the Secretary of the SCAR Working Group on Biology, have approved the statement which appears in the following pages. They believe it represents the opinion of the majority of the National Committees, and is a reasonable compromise between the view that the statement should be confined to setting out general principles and the opinion of those who would prefer more detailed recommendations.

The most important sections of the following document are those headed "General Principles" and "Recommendations". It is hoped that these sections will provide a basis on which the nations active in Antarctic research can develop a common policy on the conservation of nature in Antarctica. The introduction and annexes are intended to clarify the document and to suggest one possible way by which the General Principles and Recommendations could be implemented. Attention is drawn to the last two paragraphs under recommendations which read:

"The necessary systems of authorization must remain a matter for discussion between the responsible authorities. Some preliminary suggestions are given in Annex D.

It is suggested that nations should draft applicable regulations."

SUGGESTED FORM OF MEASURES TO PROMOTE CONSERVATION OF NATURE IN THE ANTARCTIC

Introduction

(*a*) These recommendations refer only to the region south of lat. 60° S. i.e. the area covered by the Antarctic Treaty. This treaty provides an un paralleled opportunity for international co-operation in the conservation of nature throughout one of the most scientifically important biogeographical regions of the world.

(*b*) The biological importance of the sub-Antarctic islands north of 60° S., and their affinities with the Antarctic, make it highly desirable that nature conservation in these two areas should be closely integrated. It is hoped that the nations exercising sovereignty over these islands, while taking account of the special problems involved, may consider the introduction of measures to ensure that the sub-Antarctic flora and fauna has comparable protection to that recommended for the area south of lat. 60° S.

(*c*) It is recognized that the biological resources of the Antarctic are an important source of supply for human needs, and that conservation measures based upon scientific research are essential to preserve and enhance these assets for the future.

(*d*) Existing national laws or regulations protect wild life in many parts of the Antarctic. Annex A is a list of the information available to the working group. When the Antarctic Treaty comes into force the region south of lat. 60° S. will be open to all nations for scientific purposes, and it is clearly desirable that conservation legislation should be consistent. It is hoped that Antarctic Treaty Powers will introduce measures on the lines recommended.

(*e*) The necessity for conservation of the flora and fauna of the high seas in the Antarctic regions is recognized, both for their own scientific value and because many animals, such as seals and sea birds, are entirely dependent upon them for food. However, for administrative reasons it would be difficult to apply these recommendations outside coastal waters. It is urged that the key importance of plankton in the biological economy of the Antarctic be recognized by all nations, and that activities which might impair it, such as harvesting or the introduction of alien species, should be scientifically assessed before being put into practice.

(*f*) The working group recognizes that the willing co-operation of the individual will do more to promote effective conservation in the Antarctic than any restrictive measures. An informative leaflet prepared by SCAR for issue to all persons who visit the region would be valuable, and a draft is attached (Annex B).

(*g*) Definitions of the terms used in these recommendations are given in Annex C.

General principles

1. The Antarctic flora and fauna are of outstanding scientific importance and every effort should be made to minimize interference by man. The region supports many forms of life which have no parallel elsewhere in the world, and which display some of the most perfect biological adaptations to an extreme environment. Scientific study requires that such fauna and flora be retained as far as possible in a natural state.

2. The Antarctic fauna contains species which are of world-wide appeal and interest, existing in an environment of great scenic beauty which has so

far been little impaired by man. This situation, which is now unique among the great land masses, merits preservation as a world heritage.

3. These fauna and flora are particularly vulnerable to interference Marine forms which breed on land have no defences against unaccustomed predators. The high specialization of Antarctic life precludes ready adaptation to changes in the environment; these tend to have irreversible effects, hence conservation measures should precede expansion of human activity in the Antarctic.

4. Appreciation of the inter-dependence of all forms of Antarctic life is fundamental to effective conservation. The vertebrate animals depend ultimately upon invertebrate plankton foods, and interference at any point in this balanced biological system can have far-reaching repercussions.

5. It is recognized that scientific and economic needs make justifiable demands on the Antarctic flora and fauna, and that some disturbance due to human activities is not only unavoidable, but may be desirable in the interests of conservation. Biological research is the essential basis for rationa management and utilization of Antarctic life, and for educational measures which seek to eliminate unnecessary wastage. Unnecessary pollution and contamination of atmosphere, land and water (including ice areas) should be prohibited.

6. International co-operation is essential. The restricted and discontinuous distribution of some species, the circumpolar range of others, and the wide spread migratory movement of many forms extend the responsibility for conservation beyond national boundaries.

Recommendations

1. All areas of land and fresh water, including fast ice and ice shelves, and all coastal waters south of lat. 60° S. should be recognized internationally a a nature reserve. Within this region, it should be prohibited to kill, capture or interfere with all animals (including indigenous predators) and plants with the exceptions stated in para. 5 below.

2. Species or habitats which are especially important or vulnerable should be further protected by the designation of selected areas as sanctuaries within which no form of disturbance should be permitted.

3. The deliberate introduction of alien forms of flora and fauna (excluding domestic species, which should be rigidly controlled at the lowest possibl number considering their chances of survival, capacity of reproduction and utilization by man) should be prohibited.

4. The attention of expedition leaders, ship masters and other persons in authority should be drawn to the necessity for control of activities which can cause serious harm to wildlife.

These include:

(*a*) Allowing dogs to run free.

(*b*) Flying helicopters or other aircraft in a manner which would disturb bird colonies, or landing near (e.g. within 200 yd.) such colonies.

(*c*) Driving vehicles unnecessarily close to breeding colonies of birds.

(*d*) Use of explosives or discharge of fire-arms close to breeding colonies of seals.

(*e*) Disturbance to bird and seal colonies by persistent attention from people on foot.

(*f*) The discharge of oil from ships in coastal waters.

5. The complete protection of all species envisaged in para. 1 above should be relaxed only in the following cases, which should be controlled by proper authorization on a scale that will not deplete the local stock.

(*a*) Collections and studies for scientific purposes.

(*b*) Food (meat, eggs) for men and dogs.

(*c*) Living specimens for zoological gardens.

(*d*) Taking of a strictly limited number of specimens, especially natural casualties, for private purposes.

(*e*) Exploitation of fauna for commercial gain, on terms which accord with sound conservation principles.

The necessary systems of authorization must remain a matter for discussion between the responsible authorities. Some preliminary suggestions are given in Annex D.

It is suggested that nations should draft applicable regulations.

ANNEX A

Wild life protection in Antarctica

The following laws, regulations or principles are in force at the present time (September 1960). This list is based on information supplied in response to the application in the circular SCAR 4/1/60, and verbally by delegates and is certainly not complete.

Argentina

Law 13.908 and Decreto Reglamentario No. 15.501/53 provide for the complete protection within Argentina and the territories under Argentine jurisdiction of all members of the native fauna. There are exceptions for sport, commercial exploitation, scientific, educational and cultural collection, and destruction of pests. The taking of species in the first three of these categories is subject to licence and governed by precise regulations, and the species concerned are listed under both their common and scientific names.

Argentina also has a considerable body of legislation governing inshore fisheries, exploitation of littoral algae, and other allied subjects, little of which has much relevance to the territories south of 60° S.

(Copies of laws and ordinances supplied by Argentina.)

Australia

Operations Manuals for Australian Antarctic stations provide rules for the protection of wild life. Enforcement is the responsibility of station leaders. (Verbal information from Australian Adviser on biology.)

Belgium

Belgium has no special law or regulation concerning conservation or utilization of the Antarctic flora and fauna. (Written information from Belgian delegate.)

Chile

Chilean national legislation protects wild life throughout the country, including areas in Antarctica. The taking of scientific specimens, and the killing of some species for sport or commercial purposes is permitted under licence (Verbal information from Chilean delegate.)

France

An Ordinance of 27 February 1959 forbids the killing or taking of specimens except for scientific purposes or in emergency, in Terre Adélie. (Verba information from French adviser on biology.)

Japan

Expedition members have been reminded of their moral duty to preserv wild life, and leaders of parties have been instructed to see that the maximum of protection is given. Permission to kill animals, even for scientific purposes must be obtained from the leader or other person in authority. (Verba information from Japanese delegate.)

New Zealand

Leaders of Antarctic stations have an over-all directive to conserve wilc life. Recently rather more precise instructions have been issued to reduc the number of seals killed for dog food. (Verbal information from New Zealanc delegate.)

Norway

By Royal Decree of 27 February 1953, in pursuance of section 3 in a law o 14 December 1951, it is prohibited to take Fur Seals or Sea Elephants o Bouvetøya and Peter I Öy. (Copy of Decree supplied by Norway.)

South Africa

Wild life protection orders are in force for South African sub-Antarcti islands, and some directive will probably be issued to scientific and othe staff of Antarctic bases, if these are established in any area possessing significant fauna. (Verbal information from South African delegate.)

United Kingdom

The Wild Animals and Birds Protection Ordinance of 22 March 1913, a amended in the Wild Animals and Birds Protection Order, 1955, provide complete protection for a list of scheduled birds and mammals within th

Falkland Islands Dependencies. The only sea birds protected in these ordinances are penguins, steamer-duck, and kelp geese: petrels and albatrosses are unprotected. A second schedule provides a close season for certain birds, mostly ducks and geese, which at other times are unprotected. The taking of penguin eggs is further governed by a supplementary series of regulations. Under Ordinance 8 of 1921 to consolidate and amend the laws relating to seal fishery and an Amending Ordinance of 1 April 1953, all seals are protected, except where exploitation has been specifically licensed. There are also fishery protection ordinances. (Copies of laws and ordinances supplied by United Kingdom.)

USA

The Operation Plan of Operation "Deep Freeze II" 1956–57, Annex L, directs commanding officers of all ships, shore stations, and other bases, and leaders of all parties to ensure that all personnel observe the principles of wild life conservation in Antarctica. Collection of scientific specimens by accredited persons is authorized. The taking of penguins for private collections is discouraged and made subject to conditions to ensure the proper handling of specimens. (Written information supplied by United States.)

USSR

Regulations for the protection of the fauna have been made by the Chief of Soviet Expeditions, and the leaders of parties are responsible for seeing that these are obeyed. Since 15 January 1956 the region round Haswell Island has been declared a reservation. No animals (other than fish, caught on a line) are taken for food by Soviet parties. (Verbal information from Soviet delegation.)

ANNEX B

Draft contents of a leaflet

Preservation of Wild Life

(*a*) Introduction. Explains that the leaflet is intended to familiarize the reader with Antarctic animals and birds and to enlist his co-operation in their preservation.

(*b*) Brief descriptions, with sketch and life history information of seals, birds, etc.

(*c*) A concluding explanation of the ways in which wild life may be endangered, even unintentionally.

(It is intended that copies of this leaflet should be handed to all personnel on embarkation or arrival in the Antarctic. Shore station leaders should prepare sketch maps showing the location of sanctuaries, main bird and seal colonies, and other interesting natural features in the district and should issue these to their staff, together with a list of the conservation rules applying in the area.)

ANNEX C

Definitions

Alien forms	Any living specimen of plant or animal which is not indigenous to the Antarctic.
Animal	Any vertebrate or invertebrate species, wherever it occurs.
Fauna	All vertebrate and invertebrate species, wherever they occur.
Flora	All plant species, wherever they occur.
Indigenous	Native to the region.
Invertebrate	Any form of animal life without a backbone, wherever it occurs.
Nature	Flora and fauna.
Nature reserve	An area of land, ice, fresh water, or sea in which plants and animals are maintained in their natural state as far as possible.
Plankton	All forms of plant and animal life which float in the sea.
Predator	Any animal which kills other animals for food.
Sanctuary	An area of land, ice, fresh water, or sea in which no form of interference with plants or animals is permitted.
Specimen	An individual plant or animal, or part thereof, which has been collected.
Vertebrate	Any form of animal life with a backbone, wherever it occurs.

ANNEX D

Authorization for collection of flora and fauna

It is suggested that the following principles may be usefully considered when regulations are drawn up.

(*a*) *For scientific collections*

i Permits should be personal and either non-transferable or transferable only to people employed by and collecting on behalf of the scientist concerned.

ii They should be issued only to scientists of repute, or persons recommended by reputable scientists.

iii They should be issued free of charge.

iv They should be for a defined period, and valid within a defined area.

v They should not restrict the species to be taken, or limit the number of specimens, which should be left to the responsible judgement of the scientist concerned, who knows his own needs and understands the implications of his collecting.

vi The right to export the specimens from the area should be included in the permit.

vii The person authorized to make scientific collections should submit a detailed report of all material collected or used, and of its eventual disposition.

(*b*) *Taking of animals for food*

i In recent years the depredations of expeditions upon this traditional food source have become alarmingly heavy, and are now continued without respite from year to year. For example, near several stations the stocks of Weddell Seals have been so disturbed that breeding rates have been affected and scientific research rendered difficult. Animals are killed without regard to age or sex, and even animals marked in the course of scientific studies have been taken. Without detailed biological research it is impossible to assess the permissible annual crop which the various seal colonies would stand, but it is certain that this figures is being seriously exceeded in many areas.

The time has come to consider a positive conservation policy which will prevent depletion of this important natural resource. For the time being, expeditions should be urged to provide alternative foodstuffs for men and dogs and permits to take seal should be granted as sparingly as possible.

ii Expedition leaders should be made aware of the situation and urged to use the maximum of restraint in the killing of seal and the taking of penguin eggs. They should seek biological guidance wherever possible as to the maximum permissible harvest.

iii Where permits are issued these should be valid for a limited period and within a definite area.

iv Permits should be issued to expeditions or other groups, the operations to be the responsibility of the leader who should direct the number to be taken at any one time.

v Such permits should be free of charge.

vi Records should be kept of all animals killed under permit, or in emergency, and returns made to the appropriate authority.

(*c*) *Specimens for zoological gardens*

i These should be issued personally to collectors, and should be transferable only to their appointed agents.

ii Before authority to collect is given it should be established that adequate arrangements have been made for the humane capture, efficient keeping in captivity, and safe transport of the animals to a suitable institution.

iii A limit should be placed on the species and numbers which may be taken under each permit. A prohibited list should be prepared, naming those species that cannot be maintained in good health in captivity for at least three years.

iv It should be specified that captured animals which cannot be safely transported from the Antarctic be forthwith released.

v Returns should be provided of the number of each species captured, the number dying in captivity and in transit, and the ultimate disposition of the specimens.

vi Where desirable a suitable charge should be made under each permit.

(*d*) *Specimens for private purposes*

i In principle it is considered that, while the taking of an occasional specimen of most Antarctic animals for private retention as "souvenirs" is unlikely to endanger any species, the practice is still an undesirable one. The disturbance and consequent loss which can be caused by people wandering into bird colonies to collect specimens can be out of all proportion to the number they actually kill themselves. Conversely, it is probably impossible to prohibit this practice without causing much ill-feeling and stimulating underhand activities. It is therefore better to recognize and regulate it.

ii Collection for private purposes should be allowed only under written permit. For administrative convenience this might perhaps be given by a Base Leader, or other person in authority, who could receive an over-all directive from his Government as to how many such permits to issue. It is suggested that nobody be allowed to kill more than one specimen of each species for private retention.

iii It is considered highly desirable that no person be permitted to kill any animal as a private specimen unless he has given an assurance that it will be competently prepared. Where efficient and inexpensive taxidermy services operate in a country it is an excellent scheme to require a deposit of money to be made when each permit is issued, to be returned on the submission of receipted taxidermist's bill. This is not practicable in all countries.

iv Where possible, people seeking private specimens should be urged to collect animals recently dead from natural causes and where an abundant supply of such specimens exists (e.g. Emperor Penguin chicks which have died of starvation) a Base Leader should not issue a permit to kill that species.

(*e*) *Commercial exploitation*

i Certain forms of commercial harvesting, e.g. of Fur Seals, and Elephant Seals, are considered undesirable at present in the area south of lat. 60° S. because the populations of these animals are small, and only slowly recovering from past destruction.

ii Other forms of harvesting, e.g. of plankton or Antarctic fish would strike at the whole basis of the Antarctic ecological system. Because of their likely repercussion they should not be undertaken without careful consideration.

iii In general, it is felt that all forms of exploitation should be discouraged until adequate scientific data are available.

Scientific investigations recommended by SCAR: amendments

The following amendments to the recommendations published in *SCAR Bulletin*, No. 3, September 1959, were provisionally accepted at the Fourth Meeting, August 1960. They have now been ratified by a majority of National Committees and are therefore effective.

Auroral Physics

That the title Auroral Physics be changed to Auroral and Airglow Physics, and that the items be amended to read as follows:

(*a*) The morphology of visual and sub-visual auroras, specific auroral and airglow emissions, and H.F. radio scattering regions. Location, shape and structural details of the southern auroral zone.

(*b*) The sources of energy producing geomagnetic and ionospheric disturbances, auroras and airglow in the Antarctic regions.

(*c*) The nature of the agencies causing excitation of auroral and airglow emission.

(*d*) The composition and physical state of the upper atmosphere.

(*e*) Search for, and explanation of, peculiarities in the space and time distribution of auroral and airglow features characteristic of the southern hemisphere.

Observational programmes should continue at stations well distributed in Antarctic regions using the several techniques available, such as visual observation, all-sky and parallactic photography, and photometric, spectrographic and radar techniques.

Attention is drawn to the possibility of gaining new information on the geomagnetic field in regions far from the earth by comparing Arctic and Antarctic observations on V.L.F. radio emissions, auroras and cosmic ray variations. Such comparisons may also contribute to the understanding of the mechanism of production of auroras. This possibility should be considered before fixing the positions of any new Antarctic stations.

Geomagnetism

Items (*a*) and (*b*) should be amended as follows, and other items (*c*) and (*d*) should be added.

(*a*) The existing geomagnetic observatory programme with base level control should be maintained at the 1960 level, which comprises the minimum necessary geomagnetic network in this area.

(*b*) Geomagnetic variation recordings, including quick-run and induction magnetographs for rapid variations, should be encouraged at all stations involved in high atmosphere studies and the recording and analysis should be designed to meet these requirements. The importance of low sensitivity recording is emphasized. Attention is drawn to the possible connection between geomagnetic disturbances at Antarctic stations and those at their geomagnetically conjugate stations in the Arctic area.

(*c*) Geomagnetic surveys in the Antarctic area (continent and southern sea) should be carried out and co-ordinated with the World Magnetic Survey programme. Encouragement should be given to airborne and shipborne magnetic surveys as well as surveys by sledge parties. As far as possible three components should be recorded.

(*d*) In connection with the research programmes of crustal and upper mantle geophysics in Antarctica, the following geomagnetic work should be encouraged:

(i) magnetic sounding on land and over the sea as a part of glaciological and geological research;
(ii) palaeomagnetism through the study of Antarctic rocks;
(iii) observation and analysis of regional geomagnetic secular variation, relevant to regional characteristics of the earth's crust and upper mantle;
(iv) research on regional characteristics of electromagnetic induction in the interior of the earth in this area;
(v) observation and analysis of earth-currents.

Geology

The section to be amended to read as follows:

Systematic regional mapping on sheets based on the recommendations of the Working Group on Cartography.

Although the nature of the geology and the area of exposures will control scale of sheets, it is recommended that each participating country retain one scale throughout for the regional geological maps in the sectors in which it has agreed to work. In addition to regional mapping and its ancillary studies (petrological, palaeontological) the Antarctic calls for attention within the basic framework of regional geology:

(*a*) Geomorphology and Quaternary geology including work of ice, frost and wind.
(*b*) Palaeoclimatic studies.
(*c*) Palaeomagnetic studies.
(*d*) Geochemical studies of rocks and minerals.
(*e*) Terrain beneath the ice in association with geophysical studies.
(*f*) Volcanology, study of past and present volcanisms and its products.
(*g*) Structural geology.

Glaciology

Item (*b*) should read:

(*b*) Variations in the extent of Antarctic ice:

(i) Changes of elevations by repeated seismic soundings, gravity observations and standard survey observations.
(ii) Measurements of ice movement by standard terrestrial survey methods, or, if these are not practicable, repeated astronomical fixes or other available methods.

(iii) Measurements of the wastage of ice by calving, melting, wind erosion and evaporation should be made by the appropriate methods.

(iv) Measurement of accumulation under (*c*) and (*d*) below should be combined with measurements of flow and wastage in order that a reliable figure for the mass balance of the Antarctic ice sheet may eventually be determined.

(v) Past variations should be studied by biological, geochemical, geomorphological and other methods.

Item (*d*) should read:

(*d*) The structure and temperature distribution of the inland ice sheet and ice shelves as revealed from deep pits and deep bore holes.

Gravity

Item (*a*) be amended by deleting the words "of the upper layers" in the second line.

Seismology

The addition of a new item after (*b*):

(*c*) To study microseisms to find why 3 to 10 second microseisms are in general less in winter than summer, in contrast to the seasonal variation in temperate latitudes.

Stations and transport operating in the Antarctic, 1960–61

Argentina

"Almirante Brown"	Lat. 64° 53′ S., long. 62° 53′ W.	Summer only
"Decepçión"	Lat. 62° 59′ S., long. 60° 43′ W.	Summer and winter
"Melchior"	Lat. 64° 20′ S., long. 62° 59′ W.	Summer and winter
"Orcadas"	Lat. 60° 45′ S., long. 44° 43′ W.	Summer and winter
"Teniente Camara"	Lat. 62° 36′ S., long. 59° 54′ W.	Summer only
"Esperanza"	Lat. 63° 23′ S., long. 56° 59′ W.	Summer and winter
"Ellsworth"	Lat. 77° 43′ S., long. 41° 07′ W.	Summer and winter
"General Belgrano"	Lat. 77° 58′ S., long. 38° 48′ W.	Summer and winter
"Teniente Matienzo"	Lat. 64° 58′ S., long. 60° 02′ W.	Summer and winter from 15 March 1961

General San Martín (icebreaker), *Bahía Aguirre* (transport), *Punta Ninfas* (oil tanker), *Chiriguano* (survey vessel), two S-55 helicopters and two Beavers.

Australia

Davis	Lat. 68° 35′ S., long. 77° 58′ E.	Summer and winter
Macquarie Island	Lat. 54° 30′ S., long. 158° 57′ E.	Summer and winter
Mawson	Lat. 67° 36′ S., long. 62° 53′ E.	Summer and winter
Wilkes	Lat. 66° 15′ S., long. 110° 31′ E.	Summer and winter

Magga Dan, *Thala Dan* (chartered transports), one DCH-2 Beaver, one DC-3 Dakota.

Belgium. Not in operation

Chile. Not known

France

"Camp Heurtin"	Lat. 37° 50′ S., long. 77° 34′ E.	Summer and winter
"Dumont d'Urville"	Lat. 66° 40′ S., long. 140° 01′ E.	Summer and winter
Port-aux-Français	Lat. 49° 21′ S., long. 70° 12′ E.	Summer and winter

Norsel (charter ship), helicopter.

Japan

"Syowa"	Lat. 69° 22′ S., long. 39° 35′ E.	Summer and winter

m/s *Soya* (ice-strengthened transport), two Sikorsky 58 helicopters.

New Zealand		
"Scott"	Lat. 77° 50′ S., long. 166° 44′ E.	Summer and winter

HMNZS *Endeavour*

New Zealand–U.S.A.		
"Hallett"	Lat. 72° 18′ S., long. 170° 18′ E.	Summer and winter
South Africa		
"Norway" station (Charter transport.)	Lat. 70° 30′ S., long. 2° 32′ W.	Summer and winter
United Kingdom		
Adelaide Island	Lat. 67° 46′ S., long. 68° 54′ W.	Summer and winter from February 1961
Argentine Islands	Lat. 65° 15′ S., long. 64° 16′ W.	Summer and winter
Deception Island	Lat. 62° 59′ S., long. 60° 34′ W.	Summer and winter
Fossil Bluff	Lat. 71° 20′ S., long. 68° 17′ W.	Summer and winter from February 1961
Halley Bay	Lat. 75° 31′ S., long. 26° 36′ W.	Summer and winter
Hope Bay	Lat. 63° 24′ S., long. 56° 39′ W.	Summer and winter
Port Lockroy	Lat. 64° 50′ S., long. 63° 31′ W.	Summer and winter
Signy Island	Lat. 60° 43′ S., long. 45° 36′ W.	Summer and winter
Stonington Island	Lat. 68° 11′ S., long. 67° W.	Summer and winter

RRS *Shackleton* and *John Biscoe*, MV *Kista Dan* (charter transport), HMS *Protector*.

United States		
"Byrd"	Lat. 79° 59′ S., long. 120° 04′ W.	Summer and winter
"Little Rockford"	Lat. 76° 16′ S., long. 147° 30′ W.	Summer only
"Beardmore"	Lat. 83° 17′ S., long. 175° 45′ E.	Summer only
"N.A.F. McMurdo"	Lat. 77° 51′ S., long. 166° 37′ E.	Summer and winter
South Pole	Lat. 90° S.	Summer and winter

Eastwind, *Edistio*, *Glacier*, *Staten Island* (icebreakers), *Wilhoite* (ocean station vessel), *Alatna*, *Arneb*, *Private John E. Towle* (transport), *Grenville Victory* (tanker), and numerous aircraft of various types.

U.S.S.R.		
"Komsomol'skaya"	Lat. 74° 05′ S., long. 97° 29′ E.	Summer only
"Lazarev"	Lat. 69° 58′ S., long. 12° 55′ E.	Until February 1961
"Mirnyy"	Lat. 66° 33′ S., long. 93° 01′ E.	Summer and winter
"Novolazarevskaya" (replacing "Lazarev")	Lat. 70° 45′ S., long. 11° 58′ E.	Summer and winter from February 1961
"Vostok"	Lat. 78° 27′ S., long. 106° 52′ E.	Summer and winter

Ob' and six aircraft, IL-14, IL-12, LI-2, AN-6.

ERRATA

SCAR Bulletin, No. 7, 1961

Page 89, line 41. *For* A. W. Worthington *read* E. B. Worthington.
Page 99, line 4. *For* 100 *read* 1000.

OBITUARY

Johan Gunnar Andersson, the Swedish geologist and archaeologist, was born on 3 July 1874 and died in Stockholm on 29 October 1960. He was a member of A. G. Nathorst's expedition to Spitsbergen in 1898, and led an expedition of his own to Bjørnøya the following year. He visited the Antarctic in 1901–04 as second-in-command of Otto Nordenskjöld's expedition. In 1906 he became professor of geography in Uppsala University and head of Sveriges geologiska undersökning (Geological survey of Sweden); he held the chair of geology at Stockholm University from 1925 to 1926. He also had a distinguished career in Chinese studies. His publications relating to polar studies include *Antarctic*, Stockholm, 1944; *Männen kring Sydpolen*, Stockholm, 1945; and numerous scientific papers.

Vyacheslav Vasil'yevich Frolov, Director of the Arctic and Antarctic Research Institute [Arkticheskiy i Antarkticheskiy Nauchno-Issledovatel'skiy Institut] since 1950, died on 22 August 1960 at Leningrad, aged 52. For the last twenty-three years of his life he was concerned with the Soviet Arctic: as head of the weather bureau at Ostrov Diksona, as chief synoptic meteorologist to the White Sea naval flotilla during World War II, and as a member of the research staff of the Arctic (later Arctic and Antarctic) Research Institute. He rose to become Deputy Director for Research before he took over the Directorship in 1950. The outstanding feature of the Institute's work during his Directorship has been the study of the Arctic basin by means of establishing drifting stations on the ice, and with this work Frolov himself was always closely concerned. Another important event during his Directorship, and one with which he was personally concerned, was the start of the series of Soviet Antarctic expeditions, which led in 1958 to the Institute becoming responsible for all Antarctic scientific work.

Johan Petersen, Ujuât, was born at Sagdlît in Greenland in 1867, and died in Denmark in December 1960. Petersen took part in Holm's (1883–85) and Ryder's (1891–92) expeditions to east Greenland as interpreter and became the first colony manager at Angmagssalik, where he stayed from 1894 to 1915 and again in 1923–24, playing an essential part during the first few critical years of colonization. In 1925 he became the first manager at Scoresbysund, and held this post for two periods, 1925–26 and 1934–35. The latter part of his life was spent in Denmark. Petersen became an expert on the history, language, and customs of the east Greenlanders and has contributed to several works on these and related subjects.

Nikolay Nikolayevich Zubov, the Soviet oceanographer and authority on floating ice, died on 11 November 1960, aged 75. He began his career in the Imperial Navy—he was present at the battle of Tsushima in 1904 as a midshipman—and specialized in hydrography and geodesy. It was hydrographic survey which took him first to the Arctic, in 1912. After World War I he left the navy and concerned himself entirely with oceanography, serving in the Floating Marine Scientific Institute and its successor, the State Oceanographical Institute. He was active in the Barents Sea expeditions of the *Persey*, and in 1932 made the first, and never repeated, circumnavigation of Zemlya Frantsa-Iosifa in the sealer *N. Knipovich*. He was in charge of scientific work on the high latitude expedition of the *Sadko* in 1935. He later flew extensively in the Soviet Arctic on ice reconnaissance flights, taking part in this for the last time only in 1954, when he was 69. In World War II he rejoined the navy, and reached the rank of Engineer Rear-Admiral. For almost the whole of his active career as a scientist he was associated with Moscow University, where he held the chair of oceanology for many years, almost until his death. Among his many oceanographical publications *L'dy Arkliki* [*Ice of the Arctic*] (1945) is outstanding as a summary of knowledge of sea ice behaviour never equalled or even approached in any other language. He also wrote extensively on the history of exploration.

ERRATA

The *Polar Record*, Vol. 10, No. 67, 1961

Page 367, line 2. *For* Canadian Arctic Pilot *read* Pilot of Arctic Canada.
Page 371, line 38. *After* on *read* Arctic.
Page 392, lines 23, 36. *For* Dance *read* Danco.
Page 393, line 40. *For* Dance *read* Danco.
Page 394, line 17. *For* Horseshoe Islands *read* Horseshoe Island.
Page 409, line 20. *For* −158·9° F *read* −126·9° F.
Page 429, line 41. *For* A. W. Worthington *read* E. B. Worthington.
Page 439, line 4. *For* 100 *read* 1000.
Page 453, line 1. *For* movements *read* movement.

RECENT POLAR LITERATURE

This selected bibliography has been prepared by R. J. Adie, Julia Allen, Terence Armstrong T. H. Ellison, Amorey Gethin, J. W. Glen, W. B. Harland, H. G. R. King, and Brian Roberts Its main field is the polar regions, but it also includes other related subjects such as "applied' glaciology (e.g. snow ploughs and ice engineering). For the literature on the scientific study of snow and ice and of their effects on the earth, readers should consult the bibliographie in each issue of the *Journal of Glaciology*. For Russian material, the system of transliteration used is that agreed by the U.S. Board on Geographic Names and the Permanent Committe on Geographical Names for British Official Use in 1947 (see *Polar Record*, Vol. 6, No. 44 1952, p. 546).

Reprints of "Recent Polar Literature", from Nos. 37/38 onwards, can be obtaine separately (to allow references to be cut out for pasting on index cards) from the Institute price 2*s*. 6*d*. for two prints. Copies will be sent without charge to organizations with which the Institute maintains exchange arrangements and which notify their wish to receive them Readers can greatly assist by sending copies of their publications to the library of th Institute.

To increase the usefulness of the bibliography entries have been arranged provisionally under subject headings in classified order according to the Universal Decimal Classification

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Heurgon, Jean. Il y a dix ans...à Kerguelen. *T.A.A.F. Terres Australes et Antarctiques Françaises*, No. 10, 1960, p. 8–14, illus. [Article commemorating tenth anniversary of French occupation of Iles Kerguelen.]

Brunt, *Sir* David, *ed. The Royal Society International Geophysical Year Antarctic Expedition Halley Bay, Coats Land, Falkland Islands Dependencies 1955–1959. Vol. 1, Introductions Aurora and Air-glow Geomagnetism.* London, Royal Society, 1960. xv, [405] p., illus., maps, tables, diagrs. 32 cm. £7.

Sutton, *Sir* Graham. A discussion on the results of the Royal Society's expedition to Halley Bay, Antarctica, during the International Geophysical Year. *Proceedings of the Royal Society*, A, Vol. 256, 1960, p. 145–244, diagrs. [Papers on seismology, glaciology, meteorology, ionosphere, geomagnetism and aurorae.]

Boffi, Jorge A. La campaña antártica invernal del Rompehielos "General San Martín" en 1957. *Contribución del Instituto Antártico Argentino*, No. 28, 1959, 15 p., illus., maps. [Account of Argentine Antarctic expedition, 1957. Brief notes on meteorology.]

Nagata, Takesi. *National report of Japanese Antarctic Research Expeditions 1958–1960* Tokyo, Japan Antarctic Office, Ministry of Education, 1960. 58 p., illus., maps, diagrs., tables. 20 cm. [Report to 4th meeting of SCAR 1960.]

Schulze, Adolfo A. R. La campaña antártica 1958–59. *Contribución del Instituto Antártic Argentino*, No. 44, 1959, 13 p. [Account of Argentine Antarctic expedition 1958–59 under author's command.]

BIOGRAPHY

KOSIBA, ALEKSANDER. Działalność naukowa Henryka Arctowskiego. Henryk Arctowski's scientific works. *Acta Geophysica Polonica* (Warszawa), Vol. 7, No. 3/4, 1959, 48 p., illus. (Reprint). [Short biography (English summary) and list of works.]

KNUTH, EIGIL. Aron fra Kangeq. Grønlands guldaldermester (1822–1869). *Nationalmuseets Arbejdsmark* (København), 1960, p. 45–64, illus. [Life, background and work of Greenlandic artist and writer, Aron from Kangeq.]

OLSEN, INGVARD. Inspektør N. R. Bull in memoriam. *Atuagagdliutit/Grønlandsposten*, 1960, Nr. 20, p. 17. [Biographical notes on Niels Rosing Bull, inspector of south Greenland 1797–1802. In Danish and Greenlandic.]

RUONG, ISRAEL. Harald Grundström. Född den 17 maj 1885 död den 31 aug. 1960. *Samefolkets egen tidning*, 1960, No. 8–9, p. 127, illus. [Obituary of Swedish authority on Lappish, 1885–1960.]

[BIOGRAPHY] Supt H. A. Larsen retires. *Royal Canadian Mounted Police Quarterly*, Vol. 26, No. 1, 1960, p. 3–10, illus., map. [Account of voyages through North-West Passage in RCMP ship *St Roch*.]

[BIOGRAPHY] Grønlandsmissionæren R. F. Lassen. *Atuagagdliutit/Grønlandsposten*, 1960, Nr. 14, p. 21, 23. [Biographical note on Greenland missionary R. F. Lassen, 1760–1811.]

LEISING, WILLIAM A. *Arctic wings*. New York, Doubleday and Co. [c1959.] 335 p., illus., maps (on end papers). 21 cm. $4·95. [Author's experiences as Eskimo and Indian missionary in Arctic Canada from 1940.]

SUZYUMOV, YEVGENIY MATVEYEVICH. *Zhizn', otdannaya Antarktide; Issledovatel' Antarktiki Duglas Mouson* [*A life dedicated to Antarctica; Antarctic explorer Douglas Mawson*]. Moscow, Gosudarstvennoye Izdatel'stvo Geograficheskoy Literatury [State Publishing House for Geographical Literature], 1960. 80 p., illus., map. 20 cm.

[BIOGRAPHY] Maleren Harald Moltke. 14. december 1871–24. juni 1960. *Grønland*, 1960, Nr. 8, p. 320, port. [Obituary of Danish painter and Arctic explorer.]

[BIOGRAPHY] Appointment of Dr John C. Reed as Executive Director of the Arctic Institute. *Arctic*, Vol. 13, No. 3, 1960, p. 207, illus.

LEBOURDAIS, D. M. Vilhjalmur Stefansson. *Canadian Geographical Journal*, Vol. 61, No. 2, 1960, p. 62–67, illus., map. [Biography and account of Canadian Arctic Expedition, 1913–18.]

GRIERSON, JOHN. *Sir Hubert Wilkins, enigma of exploration*. London, Robert Hale, [c1960]. 224 p., illus., map. 21½ cm. [1888–1958.]

POLAR REGIONS IN GENERAL

[POLAR REGIONS : BIBLIOGRAPHY] *The Polar bibliography, Vol. 3*, Washington, D.C., Library of Congress, Technical Information Division, 1959. ix, 258 p. 26½ cm. [1000 abstracts of unclassified reports and other documents prepared by military agencies or their contractors.]

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Greenland

ANDERSEN, TORBEN. Gensyn med Scoresbysund. *Grønland*, 1960, Nr. 9, p. 353–59, illus. [Landscape, climate and natural history of Scoresby Sund area, east Greenland.]

SØRENSEN, JANUS. Træk af Grønlands kolonisation i det 18. århundrede. *Grønland*, 1960, Nr. 10, p. 361–77, illus., map. [Danish colonization of Greenland in eighteenth century.]

HESSELBJERG, ERIK. Det grønlandske retsvæsen og dets fremtid. *Grønland*, 1960, Nr. 10, p. 387–98, illus. [Assessment of present judicial system in Greenland.]

BORNEMANN, CLAUS. Bliver den grønlandske arbejder forbigået. *Grønland*, 1960, Nr. 12, p. 459–71, illus. [Problems connected with vocational training of Greenlanders and their employment in skilled trades.]

North American Arctic

WYBOU, R. B. The DEW line. *Roundel*, Vol. 12, No. 4, 1960, p. 2–6, illus. [Construction of North American air defence system.]

[CANADA : PLACE-NAMES] Geographical names in the Canadian north. *Arctic*, Vol. 13, No. 3, 1960, p. 208.

Peacock, F. W. The Moravian Mission in Labrador. *Canadian Geographical Journal*, Vol. 60, No. 5, 1960, p. 182–89, illus., map. [Historical survey.]

Rogers, George W. *Alaska in transition, the southeast region.* Baltimore, Johns Hopkins Press, [c 1960]. xiii, 384 p., illus., maps, tables. 23 cm. $7. [Study of economic development and future of southeast Alaska.]

Antarctic

Schulthess, Emil, *and others. Antarctica. By Emil Schulthess, George J. Dufek and Henry M. Dater.* Zürich, Artemis Verlag, [c1960]. n.p., illus., maps. 20 × 34 cm. £5. 6*s*. 6*d*. [Photographs taken on Operation "Deep Freeze" 4, 1958–59.]

Ageitos, Juan M., *and* Meneses, Carlos A. La función educativa y científica de un museo antártico. *Contribución del Instituto Antártico Argentino*, No. 32, 1959, 19 p., illus. [Scientific and educational function of an Antarctic museum, with particular reference to Instituto Antártico Argentino, Buenos Aires.]

[Conferences] Antarctic symposium. Buenos Aires 17–25 Novembre 1959. *Union Géodésique et Géophysique Internationale, Monographie* No. 5, 1960, 95 p. [Synopsis of communications read.]

[Antarctica : Exploration] *Antarctica legislation, 1960. Hearings before the subcommittee on territorial and insular affairs of the interior and insular affairs, House of Representatives 26th Congress 2nd Session on H.R. 5222, H.R. 8376 and H.R. 8421...and H.R. 8480 and H.R. 8481. June 13 and 14, 1960.* Washington, D.C., U.S. Govt. Printer, 1960. 123 p. [Bills relating to continuity of Antarctic research programmes by U.S.A.]

Voronov, P. S. Nekotoryye cherty geomorfologii Antarktidy [Some features of the geomorphology of Antarctica]. *Trudy Nauchno-Issledovatel'skogo Instituta Geologii Arktiki* [*Transactions of the Research Institute of the Geology of the Arctic*], Tom 113, 1960, p. 183–208, illus., map. [Morphogenic factors, types of relief.]

[Antarctica : Maps] *Catalogue of maps and charts of Antarctica.* Canberra, Department of National Development, Division of National Mapping, 1960. 69 leaves, 21 × 34 cm. [Catalogue of maps, air navigation and hydrographic charts compiled from information of member nations of Special Committee on Antarctic Research, 1959.]

Tilman, H. W. Voyage to the Crozet Islands. *Geographical Magazine*, Vol. 33, No. 7, 1960, p. 391–99, illus., map. [1959. Also visited Iles Kerguelen.]

Le Blond, Yves. Périple des Kerguelen. *T.A.A.F. Terres Australes et Antarctiques Françaises*, No. 10, 1960, p. 41–55, illus., map. [Description of voyage round the coast of Iles Kerguelen.]

THIRTY-FOURTH ANNUAL REPORT ON THE WORK OF THE SCOTT POLAR RESEARCH INSTITUTE

The General Board beg leave to publish the following Report which they have received from the Director of the Scott Polar Research Institute on the work of the Institute for the year ending 31 July 1960.

Staff and Research Students. Dr Roberts has been appointed a Research Associate in the Institute. This is an established University post which was created to meet the particular nature of Dr Roberts's duties. He will continue to work both in the Institute and in the Foreign Office Research Department. The post will lapse on completion of Dr Roberts's tenure.

The University has also approved the establishment of the post of Librarian of the Institute, and Mr H. G. R. King, who has been in charge of the Library since 1955, was appointed to this new post from 1 October 1959.

Dr C. W. M. Swithinbank, who has been working for the Institute on sea ice studies in the Canadian Arctic since 1955, left the Institute on 15 October 1959 on completion of this work. He is to undertake glaciological field studies with the U.S. Antarctic Program under the direction of Professor J. Zumberge of the University of Michigan.

Miss A. M. Savours, the Curator of Manuscripts, was granted one year's leave of absence from 11 March 1960 to enable her to take up the Johnstone and Florence Storey Studentship awarded by the British Federation of University Women. She will study sources of polar history in Australia and New Zealand and will be attached to the Australian National University.

Miss J. Allen, a graduate of the University of Bristol, has joined the staff temporarily during Miss Savours's absence.

Mrs H. G. Hatley resigned from the clerical staff on 26 September 1959, but has continued part-time work in the Institute for the Special Committee on Antarctic Research. Mrs B. Capon joined the clerical staff on 12 September 1959.

The staff of the Institute on 31 July 1960 was as follows:

Director	Dr G. de Q. Robin
Assistant Director of Research	Dr T. E. Armstrong
Research Associate	Dr B. B. Roberts
Senior Assistant in Research	Dr S. Evans
Librarian of the Scott Polar Research Institute	Mr H. G. R. King
Editor of the *Polar Record*	Mr L. M. Forbes
Assistant Librarian and Curator of Manuscripts (on leave for one year)	Miss A. M. Savours
Temporary Assistant Librarian	Miss J. Allen
Scandinavian Abstractor	Mr P. A. B. Gethin
Research Students	Mr J. A. Heap, Mr J. Hanessian, Mr J. Tuck, Mr G. Elliston
Research Worker	Mr J. Morley (Falkland Islands Dependencies Survey)
Office staff	Mrs K. M. Hyde (Secretary) Mrs B. Capon Miss T. Deacon Mrs J. Blake (part-time) Mrs H. G. Hatley (part-time)

New developments. The University have approved the need for an extension to the

Scott Polar Research Institute provided that the funds for the extension can be raised from outside sources.

The University have approved that a second Assistant Director of Research should be appointed to the staff of the Institute as from 1 October 1960.

Teaching and research. (1) *Teaching.* Lectures to candidates for Part II of the Geographical Tripos were given by Dr Armstrong and Dr Roberts on "Polar Problems" (eight lectures) and by Dr Robin on "Polar Ice Sheets" (four lectures).

Dr Evans helped in the Cavendish Laboratory by supervision of a Physics Part I practical class.

(2) *Sea ice studies.* The ice probability analysis of Canadian Arctic waters by Dr Swithinbank has now been completed and is in the hands of the printers.

Mr J. A. Heap of the Falkland Islands Dependencies Survey is continuing his collection and analysis of data on the sea ice conditions in the Dependencies. His forecast of bad ice conditions during the 1959–60 summer in the waters of the Dependencies was again substantially correct.

(3) *Glaciology.* The Institute's close collaboration with the British Glaciological Society has been continued. The International Data Centre "C" for glaciology, which is housed in the Institute, has been allotted the task of producing the final I.G.Y. catalogue of glaciological work. Dr Robin has been given the task of editing the volume of Glaciology for *The Annals of the I.G.Y.* Mrs Richardson, who is responsible to the British Glaciological Society for the operation of the data centre, is assisting by the preparation of Antarctic and world-wide glaciological maps.

Mr G. R. Elliston has been engaged throughout the year in his field studies of the variations of glacier movement on the Gornergletscher in Switzerland. His supervisor during field work has been Professor A. Renaud, the Secretary of the Swiss Commission on Glaciers. His supporting team of surveyors and helpers has been recruited from many sources and although too numerous to list here, their invaluable assistance is acknowledged.

(4) *Oceanographic studies.* Mr J. Morley of the Falkland Islands Dependencies Survey started work in the Institute in November 1959. He will prepare a report on the operation and design of ships for use in ice.

Dr Robin has commenced an investigation of the penetration of sea waves and swell into fields of floating ice. The main studies were made during a voyage to Halley Bay in the RRS *John Biscoe* between December and February. The shipborne wave recorder was loaned initially by the National Institute of Oceanography and the cost of fitting it to their ship was borne by the Falkland Islands Dependencies Survey. The support of the work by the Governor and staff of the Falkland Islands Dependencies Survey made the work operationally possible.

(5) *Upper atmosphere physics.* Analyses of movements of auroral features and of related magnetic disturbances at Halley Bay and at certain northern hemisphere stations have been made by Dr Evans. He also continued studies of noctilucent clouds in northern Sweden in the summer of 1959. In October 1959, the Meteorological Research Flight in the United Kingdom provided facilities for high-altitude flights to be made over the Norwegian Sea in a search for noctilucent clouds. Colloquia on auroral movements, and on notilucent clouds, have been given in the Cavendish Laboratory.

(6) *Historical studies.* Dr Armstrong is continuing his studies of the Russian colonization of northern territories. An award of a Leverhulme Trust Travelling Fellowship made it possible for him to visit Moscow and the Arctic and Antarctic Research Institute in Leningrad where he was able to make full use of extensive library facilities.

Miss Savour's search for manuscript material has included visits to the Royal Scottish Geographical Society and the Royal Scottish Museum in Edinburgh, where papers relating to James Weddell and W. S. Bruce were studied. She has edited a Dundee whaling journal of 1894 for publication. Since arriving in Australia, she has spent some time working on material in the State Archives in Hobart.

Mr J. Hanessian has continued his studies of 'The development and analysis of international controls over Antarctica since 1947'. He has given a series of seminars on this subject in the Faculty of Law in Cambridge, and one at University College, London.

(7) *Economic geography.* Mr J. Tuck has continued his study of logistic problems in Antarctic development.

Publications. Three numbers of the *Polar Record*, nos. 63, 64 and 65, which include *SCAR Bulletins*, nos. 3–5 have been published during the past year.

Publications by the staff and research students include:

S. Evans and G. M. Thomas. The southern auroral zone in Geomagnetic Longitude Sector 20 E. *J. Geophysical Res.* **64** (October, 1959), 1381–8.

S. Evans. Horizontal movements of visual auroral features. *J. Atmospheric and Terrestrial Physics*, **16** (October, 1959), 190–2.

S. Evans. Systematic movements of aurora at Halley Bay. *Proc. Roy. Soc.* A, **256** (July, 1960), 234–40.

J. Hanessian. The Antarctic Treaty. *International and Comparative Law Quarterly*, **9** (July, 1960), 436–80.

J. Hanessian. Der Antarktis-Vertrag vom Dezember 1959. Ein mögliches Vorbild zur Regelung anstehender internationaler Fragen. *Europa Archiv*, 15. Jahr. 12 Folge (June, 1960), 371–84.

A. M. Savours. An Arctic whaling journal of 1791. *Polar Record*, **10**, no. 65 (May, 1960), 126–37.

A. M. Savours. Journal of a whaling voyage from Dundee to Davis Strait, 1894. *Polar Record*, **9**, no. 63 (September, 1959), 534–46.

A. M. Savours. The manuscript collection of the Scott Polar Research Institute, Cambridge. *Archives*, **4**, no. 22 (1959), 102–8.

C. W. M. Swithinbank. Ice movement inland. *Norwegian British Swedish Antarctic Expedition Scientific Results*, **3** (Norsk Polarinstitutt, Oslo, 1960).

J. Tuck. United States air-drop operations in Antarctic, 1956–59. *Polar Record*, **10**, no. 64 (1960), 23–9.

International activities. The Director, the Editor of the *Polar Record*, and the office staff are continuing their work for the Special Committee on Antarctic Research of the International Council of Scientific Unions. Preparations for the fourth meeting of SCAR in Cambridge in August–September 1960 have been made.

Dr Robin has been appointed the representative for Glaciology on the International Committee for Geophysics (C.I.G.), which has taken over responsibilities from the Special Committee for International Geophysical Year (C.S.A.G.I.).

Visits. Visits to other polar institutes by staff and research students during the past year include:

United States Antarctic Research Projects Office: Dr Roberts.
Australian National Antarctic Research Expedition headquarters: Miss A. M. Savours.
Instituto Antártico Argentino: Dr Robin.
Expéditions Polaires Françaises: Dr Robin, Mr Hanessian, Mr Tuck.
Arctic and Antarctic Research Institute, Leningrad: Dr Armstrong, Mr Hanessian.
Arctic Institute, Copenhagen: Mr Hanessian, Mr Tuck.
Norsk Polarinstitutt: Mr Hanessian, Mr Tuck.

Dr Robin attended an Antarctic symposium in Buenos Aires in November 1959 and the General Assembly of the International Union of Geodesy and Geophysics in Helsinki in July 1960.

Dr Roberts was in Washington during October and November 1959 as a member of the United Kingdom delegation to the conference which negotiated the Twelve-Power Antarctic Treaty signed on 1 December. The treaty provides the necessary political foundation for international scientific co-operation in Antarctic research.

Dr Evans attented a meeting of the International Association for Geomagnetism and Aeronomy in Copenhagen in July 1960.

Information service. Considerable interest in the functions of Polar institutes and the associated provision of information services has been shown in North America during the past year. In the U.S.A., the Ohio State University Institute of Polar Studies, and the University of Wisconsin Polar and Geophysical Research Center have been established. In Canada, the University of Alberta has founded the Boreal Institute and the University of Saskatchewan has started the Institute of Northern Studies. Senior representatives of all four institutes have visited Cambridge during the year and have been interested in the system of classification and the practice of co-operative cataloguing which we advocate, as well as co-operation in the translation of foreign language material.

Over a dozen individuals and institutions are currently receiving copies of our library cards and the possibility of extending this service to a larger clientele is at present being investigated.

As in previous years, considerable interest has been shown in the manuscript collection, from which photo-copies have been supplied to organizations and individuals in Australia, Canada, New Zealand and the U.S.A.

A start has been made on a collection of colour slides for use in lecturing; in addition to gifts received, slides of a number of standard maps have been purchased.

Visitors using the library for short periods included:

Dr O. Svarlien, University of Florida, writing a paper on territorial claims in the polar regions, with special reference to the Antarctic.

Mr A. Laurie, of Canada, working on a device to prevent ice formation in rivers.

Mr Thornton A. Sherman, Harvard University, compiling material for a thesis on marine transportation in the polar regions.

Miss A. Parry, working on a life of Sir William Edward Parry (1790–1855).

Dr John Mercer, Ohio State University, working on Alaskan and Patagonian glaciers.

Dr W. Ornstein, of Washington University, St Louis, working on the mechanical and engineering properties of snow and ice.

Finance. During the year the Institute received the following sums, which are gratefully acknowledged.

H.M. Government grant-in-aid. The sum of £1,000 was received on 10 August 1959.

New Zealand. A grant of £200 sterling was received from the New Zealand Government on 29 December 1959.

Falkland Islands Dependencies Administration. A grant of £200, being the eleventh annual subvention, was made by the Governor of the Falkland Islands on 4 January 1960.

Canada. £375. 18*s.* 10*d.* was received on 29 January 1960 under a contractual agreement with the Defence Research Board of Canada covering the year 1959–60.

Australia. A donation of £638. 1*s.* 9*d.* (£A800) authorized by the Australian Cabinet was received on 29 April 1960.

Royal Society. A Government grant-in-aid of £300 was received through the Royal Society to cover the cost of equipment and all-sky camera films for Dr Evans's study of the movement of auroral features.

Lectures. Lectures were given at the Institute during the Michaelmas and Lent Terms.

1959

24 October	"Ships and ice", by K. Lauritzen.
31 October	"Antarctic exploration yesterday and to-day", by Sir Raymond Priestley

1959	
7 November	"Antarctic temperatures", by Dr Harry Wexler.
21 November	Polar documentary films.
1960	
23 January	"Research activities of the U.S. Army on the Greenland Ice Sheet", by Dr P. Siple.
6 February	"Some achievements of the Belgian Antarctic Expedition, 1957–59", by Professor E. Picciotto.
20 February	"Review of Cambridge Geological Work in Spitsbergen, 1949–59", by W. B. Harland.
27 February	"Glaciological work at Little America", by Dr A. P. Crary.
5 March	"The Royal Canadian Air Force in the Arctic", by Wing Commander J. G. Showler, A.F.C., C.D., R.C.A.F.

In addition to the lectures mentioned above there was another series, intended primarily for undergraduates and specialists, on 'Life and work in polar regions'.

1960	
22 January	"Dog sledging", by Dr R. J. Adie.
29 January	"Ventilation, warmth and carbon monoxide problems", by Dr Griffith Pugh.
5 February	"Survival in cold water", by Surgeon Lieut. Cdr. D. J. Kidd.
12 February	"Food requirements", by Dr J. P. Masterton.
26 February	"Openings for graduates—the Falkland Islands Dependencies Survey", by W. O. Sloman.

Friends of the Polar Institute. The membership is now 261 representing a total subscription of about £312 a year. Donations received were approximately £250. The continued generosity and support of the Friends are greatly appreciated.

Gino Watkins Memorial Fund. Three Watkins grants of £40 each were made in April 1960 to:

Cambridge Expedition to Svartisen, 1960.
Leeds University Expedition to Sarek, 1960.
Oxford and Cambridge Expedition to Finnmark, 1960.

Museum. An exhibition of maps and photographs was held in connexion with the Commonwealth Survey Conference. The Directorate of Overseas Survey provided a particularly fine exhibit for it, and Messrs Hunting Aerosurveys Limited also went to considerable trouble to secure suitable photographs. The Royal Canadian Air Force provided an exhibit on their work in the Canadian Arctic.

During July 1960 the museum was completely redecorated, and a new lighting system installed in the entrance hall consisting of shades, in the form of inverted cones, directing light on to the ceiling maps.

Library. Publications received during the year numbered 1,621. Of these, 539 were gifts, 426 were purchased and 656 received in exchange for the *Polar Record.* Maps and charts numbered 1,351. Over 4,534 abstracts of journals and books were compiled and added to the classified catalogue; 1,400 were published in the *Polar Record.*

A non-recurrent grant of £500 from the University has enabled the library to bring up to date the binding of its more valuable periodical sets.

A number of interesting manuscripts have been added to the collection. Sir Raymond Priestley has presented the journals of his Antarctic cruises in the Royal Yacht *Britannia*, 1956–57, and with the U.S. Navy on "Deep Freeze" IV, 1958–59. Among numerous meteorological logs deposited on permanent loan by the Meteorological Office, Harrow, are those of H.M. ships *Erebus* and *Terror* from 1839 to 1843.

The generosity of the Friends has enabled the Institute to purchase six watercolours painted by John Edward Davis, Second Master of H.M.S. *Terror* during the British Antarctic expedition of 1839–41, led by Sir James Clark Ross.

Gifts. The institute is most grateful for the publications sent to the Library in exchange for the *Polar Record* and regrets the impossibility of acknowledging each one individually.

We wish to thank the many people and organizations who have kindly presented the following items:

Books and reprints

Dr Otto Abs
Dr R. J. Adie
Yrjö Alaruikka
Dr T. E. Armstrong
M. Aurousseau
J. K. Bannon
S. Bartl
P. P. G. Bateson
Professor A. Bauer
Dr C. R. Bentley
Dr G. C. L. Bertram
Professor J. Brian Bird
Dr K. Birkenmajer
L. C. Bliss
R. W. Boyle
Professor Dr B. Brockamp
F. E. Bronner
Mrs L. Brooks
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Dr C. W. M. Swithinbank
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S. Taylor
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S. Thorarinsson
W. L. N. Tickell
Professor B. A. Tikhomirov
A. F. Treshnikov
J. Tuck
S. M. Uspenskiy
Gorow Wakahama
J. Weertman
Dr H. Wexler
P. J. Williams
Dr J. W. Wilson
L. W. Wing
Sir James Wordie

Admiralty, Hydrographic Office
Air Ministry, Meteorological Office
Aluminium Development Association, London
American Geographical Society
American Museum of Natural History
British Glaciological Society
Bureau of Mineral Resources, Geology and Geophysics, Canberra
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Colorado School of Mines
Commissions des Glaciers Suisses
Commonwealth Scientific and Industrial Research Organization, Melbourne

Dartmouth College, New Hampshire
Department of External Affairs, Melbourne
Deutsche Akademie der Wissenschaften zu Berlin
Director of Fisheries, Cape Town, South Africa
Division of Tourist and Economic Development, Juneau, Alaska
Documentation Française, Paris
Dominion Observatory, Ottawa
Durham University Exploration Society
Edward Grey Institute of Field Ornitholog
Expédition Glaciologique Internationale au Groenland
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"Mining Engineering", New York
National Academy of Sciences, Space Science Board
National Institute of Oceanography
National Science Foundation, Washington, D.C.
Northern Canada Power Commission
Panstwowe Wydawnictwo Naukowe, Poland
Provincial Museum of Natural History and Anthropology, British Columbia
Research Council of Alberta
Royal Canadian Air Force Survival Training School
Royal Canadian Mounted Police
Royal Scottish Museum
Royal Society, Edinburgh
Royal Society, London
Scripps Institution of Oceanography
Skid och Frilufts Framjandet
Special Committee on Antarctic Research
State Historical Museum, Juneau, Alaska
Terrestrial Sciences Laboratory, Bedford, Mass.
U.S. Air Force, School of Aviation Medicine
U.S. Army Attaché, London
U.S. Embassy, Office of Naval Attaché, Bureau of Ships
U.S. House of Representatives
U.S. Naval Air Development Center
U.S. Senate, Interstate and Foreign Commerce Committee
University of Alaska
University of Alaska, Geophysical Institute
University of Birmingham
University of Michigan Research Institute
University Museum, Philadelphia
University of Sydney
University of Washington, Department of Meteorology and Climatology
University of Washington, Department of Oceanography
Zakrad i Observatorium Meteorology i Klimatology, Warsaw
Zoological Society of London

Maps and charts

Baron Gaston Gerlache de Gomery
Commander A. E. Harboard, R.N.
J. Kowalewski
Sir James Wordie
Admiralty Hydrographic Department
Australia Department of External Affairs, Antarctic Division
Australia, Division of National Mapping
Canada, Hydrographic Service
Canada, National Research Council
Chile, Departamento de Navegación e Hidrografia
Directorate of Overseas Surveys
Expéditions Polaires Françaises
National Science Foundation, Washington, D.C.
New Zealand Geological Survey
Norsk Polarinstitutt
Research Council of Alberta
Royal Society
Soviet Delegation to the Antarctic Conference, Washington, 1959
United States Antarctic Projects Office
U.S. Hydrographic Office
U.S. Geological Survey

Manuscripts, etc.

Track charts of *Thala Dan* and *Magga Dan*, 1959	Australian National Antarctic Research Expeditions
Papers from British Antarctic Expedition, 1910–13	Mrs Angela Cherry-Garrard
Expedition log of the Gough Island Scientific Survey, 1955–56, leader J. B. Heaney	Gough Island Scientific Survey, 1955–56
Sir George Hubert Wilkins. Report of the expedition for the American Geographical Society, 1929	John Grierson
Meteorological logs of H.M. Ships: *Isabella* (1818) *Erebus* and *Terror* (1841–43) *Investigator* (1848–49)	Meteorological Office, Harrow (Permanent loan)

Isabel (1852)
North Star (1852–54)
Rattlesnake (1852–54)
Resolute and *Intrepid* (1852–54)

Four meteorological logs of British National Antarctic Expedition 1901–04 including one of sledge journeys	Meteorological Office, Harrow (Permanent loan)
Provisional map of South part of Victoria Land	New Zealand Geological Survey, Trans-Antarctic Expedition, 1955–58
Journals kept during the Antarctic cruise of Duke of Edinburgh in Royal Yacht *Britannia*, 1956–57 and on "Deep Freeze" IV, 1958–59	Sir Raymond Priestley
The Adélie Mail with which is incorporated the Cape Adare Times	Sir Raymond Priestley
Scrapbook of papers, published and unpublished, relating to Sir T. W. E. David	Sir Raymond Priestley
Microfilm copy of original journals and papers in the Public Archives of Canada relating to the British Arctic Expedition, 1875–76, leader Sir George Nares	Public Archives of Canada
Photocopy of 1829 chart of western part of South Shetland Islands	Dr B. B. Roberts
Photocopy of 1941 map of Andersen Harbour, Melchior Islands—Dallman Bay, Antarctic	Dr B. B. Roberts
Jack Tuck and Paul Siple, South Pole station Daily narrative log (unofficial) 1957	J. Tuck
Nine base plans, Antarctic	United States Antarctic Projects Officer
Papers, maps and geological sections relating to the Scottish Spitsbergen Syndicate Expeditions 1919–20	University of Edinburgh Department of Geology

Recorded sound

Steel ships in ice. Lecture given by H. C. Petersen to the Institute of Navigation, 19 June 1959. [Tape recording.]

The singing sailor. Whaling shanties. From gramophone record produced by Workers' Music Association Limited, London, 1955. [Tape recording.]

Experiences on Scott's Northern party. Lecture given by Sir Raymond Priestley to Clare College, Cambridge, Research Students Group, 25 June 1960. [Tape recording.]

Photographs, negatives, slides, films, etc.

Dr T. E. Armstrong
R. Carrick
V. D. Carse
J. W. Cowie
M. M. R. Freeman
J. A. Heap
K. Lauritzen
B. Lüncke
T. H. Manning
J. P. Morley
Sir Raymond Priestley
J. M. Robinson
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Dr C. W. M. Swithinbank
Y. Tinbergen
L. H. Warnant
C. B. Wilson
F. E. Wooden
Arctic Club
Australian National Antarctic Research Expeditions
Expéditions Polaires Françaises
Falkland Islands Dependencies Survey
Francis Edwards Limited
National Museum of Canada
National Research Council of Canada
Public Library, Dundee
Royal Canadian Air Force
U.S. Army Polar Research and Development Center
U.S. Navy
Wilson, Nuttall, Raimond

Museum exhibits, equipment, etc.

Two plates from *A voyage of discovery made under the orders of the Admiralty in His Majesty's ships Isabella and Alexander...*, by John Ross, London, 1819

Three mezzotints of polar hunting scenes, Edward Arme, London, 1813

Half-tone plate showing a group of four walruses or sea horses, undated	
Coloured line engraving "Landing the treasures, or Results of the Polar expedition", by C. Cruickshank, 1819	
Two lithograph portraits of Sir John Franklin: (*a*) Published by Fisher, London, 1830 (*b*) From *Portrait gallery of Hogg's Instructor*	
Engraving of a portrait of P. L. M. de Maupertins by R. Tournière	
Two engravings of portraits of Sir William Edward Parry: (*a*) By W. H. Brooke, 1823 (*b*) By C. Hullmandel, 1823	
Three portraits of Sir John Ross: (*a*) Line block of A. Croquis (*b*) Half-tone drawing (*c*) Lithograph	
Coloured print *The South Pole (Lieutenant Shackleton)* by Kite	
Six water-colours by J. E. Davis, Second Master of H.M.S. *Terror*, during British Antarctic Expedition, 1839–43, led by Sir James Clark Ross	Friends of the Polar Institute
Two silhouettes of Admiral Sir William Edward Parry	Reverend Keatinge Clay
Cover, Argentine I.G.Y. Antarctic stamp, issued in connexion with an exhibition "Antarctica and the I.G.Y.", 8–13 June 1959	Admiral R. N. N. Panzarini
Sketch of *Fox* off Osborne, 19 July 1860	Francis Edwards Limited
Ten plates from *Voyage au Pole et dans l'Océanie sur les corvettes, l'Astrolabe et la Zélée, 1837–40, sous le commandant de M. Dumont d'Urville*, Paris, 1846	Sir James Wordie
Set of eight contemporary lantern slides of the British Arctic Exhibition 1875–76, oil paintings on glass	R. F. Atherton
Set of three postcards with postal frank of Japanese Antarctic Research Expedition IV, 1959–60	S. Moranchi and N. Wakai

A large circumpolar map of Arctic regions which is suitable for display during lectures was presented by Scandinavian Airlines System in February 1960

G. DE Q. ROBIN, *Director*

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PRINTED IN GREAT BRITAIN AT THE UNIVERSITY PRESS, CAMBRIDGE
(BROOKE CRUTCHLEY, UNIVERSITY PRINTER)